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A SECOND SUMMARY OF THE SCROPHULARIACEAE OF NEW GUINEA*

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With five plates

THE third series of Archbold Scrophulariaceae from New Guinea differs from its predecessors in coming from the western or Netherlands half of the island.¹ The specimens have again been gathered by Mr. L. J. Brass, but this time some were collected jointly with Dr. E. Myer-Drees, a forester who accompanied the expedition on behalf of the Netherlands government. The expedition entered from the northern coast and climbed Mt. Wilhelm in the Snow Mountains. The Scrophulariaceae found at high altitudes, mostly species of *Hebe* and *Euphrasia*, seem to be wholly endemic, and show what a break must occur in the highest zones of vegetation between this mountain and the previously visited Carstensz Peak in the Nassau Range, several degrees to the westward.²

Since political conditions will probably prohibit for some years further botanical exploration of the mountains of New Guinea, it seems appropriate to present now a summary of our present knowledge of the Scrophulariaceae of the island. It is nineteen years since the last such record, "Die Scrophulariaceen Papuasien,"³ by Dr. R. Schlechter, a study enumerating 26 species in all, 19 of which were lowland and 7 alpine. With continued exploration, figures for both the lowland and the highland species have increased, but the lowland mainly by the addition of widespread Indo-Malayan plants, while the highland count builds up by endemic restricted species. The figures now are 34 for the lowland and 25 for the highland, making a present total of 59 species. The sharp separation of lowland

*Botanical Results of the Richard Archbold Expedition.

¹For account of the Third Archbold Expedition, which visited New Guinea in 1938, see Richard Archbold's "Unknown New Guinea" in *Nat. Geogr. Mag.* **79**: 315-344, 1941.

²See "Report on the Botany of the Wollaston Expedition to Dutch New Guinea, 1912-13," by Henry N. Ridley, in *Trans. Linn. Soc. II. Bot.* **9**: 1-284, 1916.

³In *Bot. Jahrb.* **59**: 99-117, 1924.

and highland floras for this family in New Guinea, first pointed out by Schlechter and discussed in my reports on the Scrophulariaceae of the First and Second Archbold Expeditions,⁴ is made more emphatic as collections accumulate. In this family it is a tribal rather than a generic matter, the Gratioleae and Buchnereae being lowland, and the Veroniceae and Euphrasiae alpine.

To make the present summary as complete as possible, it will be necessary to consider again some problems based upon the earlier expeditions and therefore concerning plants of eastern New Guinea. Also, there have reached me, either directly or through the Arnold Arboretum, various collections made by Mrs. Mary Strong Clemens in the mountains of the Morobe District or the Saruwaket Range, both being in Northeastern New Guinea. These will also be reported in the present paper.

But this material, altogether, does not contain many collections, and it would have been indeed desirable to have seen what specimens are in the herbarium at Buitenzorg, Java, and in the herbaria of Germany and England. But, even with those, any enumeration now is but a milestone directing to the task yet before us in adequately collecting for study the New Guinean flora. There are still undescribed lowland Scrophulariaceae, though these will be vastly outnumbered by the alpine species of *Hebe* and *Euphrasia* certain to be revealed as expeditions reach more isolated mountain areas.

As in previous papers, the present summary will present keys when thought needed. Additions to the island's flora will be starred. It hardly seems necessary to explain the obvious abbreviations to herbaria: AA — Arnold Arboretum; ANSP — Academy of Natural Sciences of Philadelphia; GH — Gray Herbarium; Mich — University of Michigan.

KEY TO THE GENERA IN NEW GUINEA

- A. Corolla with the upper lobes external, overlapping in the bud; stigmas distinct; leaves opposite or ternate, often glandular-punctate; lowland. (Antirrhinoideae-Gratioleae).
- B. Anther-cells separated on short arms of the connective; leaf-blades glandular-punctate.
 - C. Anthers all developed, polleniferous; capsule globose to ovoid; sepals alike; bracts leaf-like, the inflorescence foliose.
 - D. Bracteoles none; sepals distinct; capsule depressed-globose, equally septicidal and loculicidal; seeds longitudinally lined; corolla 4–5 mm. long; leaf-blades ovate, petioled. 1. *Poarium*.
 - DD. Bracteoles developed, a pair beneath the calyx; sepals united proximally; capsule globose to ovoid, primarily loculicidal; seeds vestigially reticulate to smooth; corolla 7–15 mm. long; leaf-blades various. 2. *Limnophila*.
 - CC. Anthers unequally developed, one cell of those on longer pair of filaments abortive; capsule conic, twice as long as wide, septicidally and then loculicidally dehiscent; sepals unequal, the posterior largest; bracteoles present beneath calyx; bracts much smaller than the leaves, the inflorescence of spikes or spike-like racemes. 3. *Adenosma*.
- BB. Anther-cells contiguous.

⁴First Expedition reported in Brittonia **2**: 177–188. 1936, and **3**: 95. 1938; Second Expedition in Jour. Arnold Arb. **20**: 75–84. 1939.

- C. Bracteoles developed, a pair at base of the unequal sepals; corolla white, with violet lines; anther-cells parallel; capsule about equally septical and loculicidal; leaf-blades glandular-punctate. 4. *Mella*.
- CC. Bracteoles none; corolla more or less violet-blue or purplish; anther-cells divaricate; leaf-blades not (or in some species of *Lindernia* slightly) punctate.
- D. Anterior filaments straight, from their lowest contact free from the corolla-tube; capsule loculicidal; sepals united proximally; bracts subulate. 5. *Mazus*.
- DD. Anterior filaments adnate to corolla as antero-lateral ridges, distally free and each sharply bent back upon itself (this appearing as a knob-like process), thence abruptly ascending; capsule septical.
- E. Placenta covering entire width of the septum; capsule 7 mm. long, globose-ovoid; corolla 20 mm. long, pale purple; leaves sessile, lanceolate-attenuate, the longer 10-15 mm. long. 6. *Artanema*.
- EE. Placenta covering median half or less of septum, which, including its bare lateral portions, persists as a thin plate; capsule globose-ovoid to linear-cylindric; corolla smaller; leaves petioled or sessile, the blades much smaller.
- F. Sepals distinct or united partially, plane, the calyx, if as long as the capsule, not investing it; bracts all opposite, usually leaf-like (subulate only in *L. antipoda*) 7. *Lindernia*.
- FF. Sepals united nearly throughout, the calyx exceeding the capsule and closely investing it; bracts foliose or more usually subulate, the pedicels (by suppression of internodes) sometimes in fours. 8. *Torenia*.
- AA. Corolla with the lower or lateral lobes external, overlapping in the bud; stigmas wholly united, capitate or punctiform; leaf-blades not punctate. (Rhinanthoideae).
- B. Upper lobes of corolla simply spreading, distinct or united; anthers all distinct, glabrous, unawned; seeds many, wingless.
- C. Sepals distinct; stamens two, the postero-lateral pair alone developed; anther-cells equal; corolla tubular-campanulate to rotate; seeds flattened, smooth; pedicels not bracteolate; alpine. (Veroniceae).
- D. Corolla 25-28 mm. long, the lobes five, much shorter than the tube; flowers solitary, sessile; stems woody. 9. *Detzneria*.
- DD. Corolla smaller, the lobes (by fusion of the posterior) appearing four, as long as or longer than the tube; flowers racemose, pedicelled.
- E. Capsule turgid, septical; stems woody, erect or diffuse. 10. *Hebe*.
- EE. Capsule flattened, loculicidal; stems herbaceous, prostrate. 11. *Veronica*.
- CC. Sepals united at least half their length; stamens four, both pairs developed; anther-cells not equal; corolla campanulate or salverform, the tube longer than the five distinct lobes; capsule loculicidal; seeds reticulate; pedicels bibracteolate; lowland. (Buchnereae).
- D. Corolla campanulate, yellow; anther-cells two, unequal; calyx not tubular.
- E. Calyx symmetrical, externally glabrate, internally densely and softly hairy, the hairs appearing as a fine ciliation of the triangular calyx-lobes; corolla 5-6 mm. long, spreading-campanulate; capsule 5 mm. long, wholly loculicidal; leaves linear, entire or with a pair of slender lobes. 12. *Sopubia*.
- EE. Calyx asymmetrical, deeply cleft anteriorly and distally so upcurved that the short free lobes appear as tips to upper side of corolla and capsule, externally densely hispid, internally glabrous; corolla 17-20 mm. long, more narrowly campanulate; capsule 7-8 mm. long, secondarily also somewhat septical; leaves linear-lanceolate, entire. 13. *Centranthera*.

- DD. Corolla salverform, the narrow throat hairy within; anther-cell one, the other lost by abortion; calyx tubular, more or less ribbed.
- E. Corolla-tube straight, the corolla pink, bluish or white; ribs of calyx relatively faint; leaf-blades narrowly elliptic to linear-lanceolate... 14. *Buchnera*.
- EE. Corolla-tube decurved near apex, the corolla reddish-purple, orange-yellow, or white; ribs of calyx pronounced; leaf-blades linear to filiform... 15. *Striga*.
- BB. Upper lobes of corolla united to form a concave galea, the white or violet corolla strongly zygomorphic; anthers cohering or distinct, the cells hairy and unequal, awned; capsule loculicidal; seeds few, with slightly raised longitudinal wings (or wing-like ridges); alpine. (*Euphrasiaeae*)... 16. *Euphrasia*.

*1. *Poarium* Desvaux

(Genotype, *P. veronicoides* Desv., the only original species)

This generic name, appearing in Hamilton's *Prodromus Plantarum Indiae Occidentalis*, p. 46, 1825, is the oldest applicable to the group to which I have applied the recent name *Lendneria* Minod of 1918. It is a genus of some 20 species, distinguishable from *Stemodia* L., also neotropical, by seeds lined or ridged instead of vestigially reticulate, capsules thinner-walled, bracteoles wanting instead of present beneath sepals, leaf-blades petioled instead of clasping, and usually (but not constantly) by corolla-throat hairy within on the upper instead of the lower side. The following much-described species, a widespread tropical weed, proves to be also in New Guinea.

*1. *Poarium verticillatum* (Miller) comb. nov.

Erinus verticillatus Miller, Gard. Dict. ed. 8. n. 5. 1768. Collected at Vera Cruz in 1731 by William Houstoun; type seen at British Museum in 1930.

This was later described as *Capraria humilis* Ait. (1789), as collected in the East Indies by J. G. Koenig; again as *Stemodia parviflora* Ait. (1812), its best known name and actually based on *Erinus verticillatus*; and finally as *Poarium veronicoides* Desv. from Hispaniola, the type of which, in the Museum d'Histoire Naturelle at Paris, I saw in 1930.

NORTHEASTERN NEW GUINEA: Morobe District, Lae, Mary S. Clemens 10447 (AA); Malahang Station, mission grounds, Mary S. Clemens on May 29, 1940 (ANSP).

2. *Limnophila* R. Brown

Schlechter (in Bot. Jahrb. 59: 100. 1924) credits four species to New Guinea and the Bismarck Archipelago, distinguishing them by key and giving their occurrence. These are all Indo-Malayan and are presumably immigrants to New Guinea from farther west. Two, *L. aromatica* (Lam.) Merr. and *L. fragrans* (Forst.) Seem., have been already reported from earlier Archbold Expeditions in Brittonia 2: 181. 1936, and in Jour. Arnold Arb. 20: 76. 1939. Of these *L. aromatica* appears to occur at low altitudes throughout the island, and it was collected in 1938 on the Balim River (*Brass* 11827). *L. rugosa* (Roth) Merr., probably equally widespread, has been gathered at Hombron Bluff, British New Guinea, by L. J. Brass (no. 1651), and at the Kajabit Mission, Morobe District, Northeastern New Guinea, by M. S. Clemens (no. 10437K), the latter getting

it from "girls who prize the fragrant leaves," and the former stating that the natives carry it in their armbands, using it at dances and feasts. Brass reports it as smelling "strongly of aniseed" and describes the flower as with "lavender blue mouth, tube yellow." The remaining species is the widespread oriental aquatic, *L. sessiliflora* (Vahl) Blume.

3. *Adenosma* R. Brown

Schlechter (l. c. 102) credits two species to New Guinea, *A. javanicum* (Bl.) Koord. and *A. papuanum* Schlechter, to which in 1939 I added *A. ternatum* and now propose *A. punctatum*. The first species, an Indo-Malayan plant remarkable for the resemblance of its calyx to the *Bacopa* alliance of neotropical America, is only remotely related to the others. The four may be distinguished as follows:

- A. Sepals hirsute, not reticulate, the outer lanceolate to oblong-lanceolate, 2 to 4 times the width of the inner two; flowers in definite spikes, the bracts much smaller than the leaves; capsule sulcate on septal line; leaf-blades dentate; stem erect.
- B. Root perennial; stem hirsute, not glandular.
 - C. Leaves ternate, the blades minutely glandular-punctate beneath, 2-2.5 cm. long; corolla 10 mm. long, externally glabrous; capsule 7-8 mm. long.... 1. *A. ternatum*.
 - CC. Leaves opposite, the blades with larger glandular dots, 1.2-1.5 cm. long; corolla 7-8 mm. long, externally finely pubescent; capsule 5 mm. long.... 2. *A. punctatum*.
- BB. Root annual; stem finely pilose with glandular hairs; leaf-blades 1.8-2.9 cm. long; corolla 12 mm. long, externally finely glandular-pubescent..... 3. *A. papuanum*.
- AA. Sepals finely pubescent, strongly reticulate, the outer widely ovate-cordate, many times the width of the inner two; flowers isolated in axils of the functioning leaves; capsule not sulcate over septum; leaf-blades crenate; stem extensively repent..... 4. *A. javanicum*.

1. *Adenosma ternatum* Pennell in Jour. Arnold Arb. 20: 77. 1939.

Collected by *L. J. Brass* (no. 7816) on the Fly River in British New Guinea.

*2. *Adenosma punctatum* sp. nov.

Herba perennis, 3-4 dm. alta, ramosa; caulis et rami teretiusculi, hirsuti, eglandulosi; folia opposita, petiolata, ovata, obtusa, basi rotundato-cuneata, margine dentata, utrinque hirsuto-pubescentia, laminis 1.2-1.5 cm. longis, 9-12 mm. latis, petiolo 5-10 mm. longo; flores inferiores plus minusve remoti, alii in racemum spiciformem congesti; bracteolae duae, lineares, calyce breviores; sepala inaequalia, lanceolata vel lineari-lanceolata, 5-6 mm. longa; corolla 7-8 mm. longa, tubulosa, bilabiata, extus minute pubescens, labio supero apice retuso, labio infero hirsuto, trilobato, lobis retusis; stamina glabra, connectivis globosis, antherarum superarum cellulis aequalibus, sed inferarum uno rudimento inaequalibus; capsula 5 mm. longa, nigra, latere ad septum sulcata, loculicida et tardius etiam septicida; semina 0.3 mm. longa, ovoidea, minute lineata.

Root not seen, but thickened bases with several stems ascending therefrom denote a perennial duration. Stem 3-4 dm. tall or more, branched (many branches abbreviated, forming axillary leafy fascicles, but the upper

branches ascending-spreading). Stem and branches slightly angled, laxly foliate. Leaves opposite, petiolate, the blades ovate, obtuse, dentate, above pilose-hirsute, beneath paler and glandular-punctate, hirsute on the larger veins, 1.2–1.5 cm. long, 9–12 mm. wide, at base widely cuneate or rounded to hirsute petioles 5–10 mm. long. Bracts smaller, the upper nearly spatulate and not exceeding the sepals. Lower flowers few and isolated, the upper numerous and forming short spike-like racemes. Lower pedicels becoming 2 mm. long, the upper shorter. Bracteoles linear, shorter than the calyx. Sepals unequal, lanceolate, the inner nearly linear, all obtuse, 5–6 mm. long, hirsute, the uppermost longest and widest, oblong-lanceolate. Corolla 7–8 mm. long, tubular-bilabiate (without record of color), externally finely pubescent; upper lip projecting-arched, its lobes rounded, scarcely distinct at the retuse apex; lower lip 2-ridged and pilose-hirsute thereon, distally with three retuse lobes. Filaments glabrous, the anterior pair longer; connective knob-like; postero-laterals with two nearly equal anther-cells, antero-laterals with one anther-cell developed, the other rudimentary. Stigmas wide, apparently plate-like, the apex of the fused styles thick-winged. Capsule 5 mm. long, conic, distally attenuate, black, firm, laterally furrowed on septum, loculicidal and secondarily somewhat septicidal. Seeds 0.3 mm. long, ovoid, brown, minutely lined.

NORTHEASTERN NEW GUINEA: Morobe District, Malolo Mountains, alt. 240–270 m., *Mary S. Clemens 4359* (AA, TYPE), November 1936, in late flower and fruit.

The name refers to the strong dotting of the leaves, but there are other species, especially *A. glutinosum* (L.) Druce, that show it as pronouncedly.

3. *Adenosma papuanum* Schlechter in Bot. Jahrb. **59**: 103. 1924.

Northeastern New Guinea.

4. *Adenosma javanicum* (Blume) Koorders. See Schlechter, l. c. 102. 1924.

Northeastern New Guinea.

4. *Mella* Vandelli

Differs from *Bacopa* Aubl. (1775) and *Herpestis* Gaertn. fil. (1807) in definitely bilabiate corollas, pinnately veined leaf-blades, and erect habit. I have previously used for this dominantly neotropical genus the name *Caconapea* Cham. (1833), the earliest typifiable generic name, since *Mella* (Vand. Fl. Lusit. et Bras. 43. 1788) appeared without citation of species. The latter would therefore be invalid under the American Code but valid under the new International Rules of Botanical Nomenclature. There are a few oriental species, the following extending to New Guinea and northern Australia.

1. *Mella floribunda* (R. Br.) comb. nov.

Herpestis floribunda R. Br. Prodr. Fl. Nov. Holl. **1**: 442. 1810.

Originally described from tropical northeastern Australia. Collected in British New Guinea by L. J. Brass, no. 3730, and reported as *Bacopa floribunda* in Brittonia **2**: 181. 1936.

*5. *Mazus* Loureiro

Both Brass' and Mrs. Clemens' collections bring this genus into the flora of New Guinea, its representative being the common tropical weed that has

been included in *M. japonicus* (Thunb.) Kuntze, but which seems to be separable by the following contrast:

- A. Leaf-blades widely oblong to nearly oval, cuneately narrowed to petioles often as long as the blades; lower pedicels usually longer than the calyces; plants (stems, leaves, pedicels, and calyces) minutely, and scarcely or not glandularly, pubescent, or (especially the leaves) glabrous.....*M. japonicus*.
- AA. Leaf-blades oblanceolate to narrowly obovate, primarily runcinate-lobed, attenuate to ill-defined petioles; lower pedicels usually about equaling the calyces; plants hirsute-pubescent, the hairs largely glandiferous.....*M. goodenifolius*.

Mazus japonicus, described from Japan, is mainly a plant of warm temperate climates, and has become adventive to the New World. *M. goodenifolius* is more definitely tropical and oriental. I had suspected that it would prove to be Loureiro's *rugosus* from Cochinchina, but his description of the leaf-shape precludes that possibility.

*1. ***Mazus goodenifolius*** (Hornemann) comb. nov.

Gratiola goodenifolia Hornemann, Enum. Pl. Hafn. 19. 1807. Original description not seen, but its diagnosis⁵ quoted in Willd. Enum. Pl. Hort. Berol. 654. 1809, where it is included as a synonym of *Hornemannia bicolor* Willd., there described from "India orientalis." I suspect from the alteration of Willdenow's primary diagnosis to "H. foliis obovatis basi integerrimis, calycibus patulibus pedunculisque glabris," that the latter was based primarily upon material of *M. japonicus*, since the omitted account of an incised-serrate narrow leaf-blade would denote the plant now considered, while the allusion to glabrous pedicels and calyces could only be to *M. japonicus*. In both the corolla would be bicolorous, the upper lip blue, the lower white.

An oriental weed, widespread over New Guinea. Collected in 1938 by L. J. Brass in Netherlands New Guinea, no. 11403 from Bele River, north-east of Lake Habbema, and no. 12925 from Bernhard Camp on the Idenburg River. Also gathered by Mary S. Clemens in the Morobe District of Northeastern New Guinea, no. 4975 in 1937 from Ogeramnang, and no. 11286F in 1940 from Matap.

6. ***Artanema*** D. Don

(Genotype, *Torenia fimbriata* Hook., from Australia.)

1. ***Artanema longifolium*** (L.) Vatke.

Earlier than my record (in Jour. Arnold Arb. **20**: 78. 1939), this wide-ranging Indo-Malayan plant had been gathered by Branderhorst in 1907 at Merauke in southeastern Netherlands New Guinea and reported by Diels and Lanjouw in Nova Guinea Bot. **14**: 534. 1928.

7. ***Lindernia*** Allioni

With the including of *Ilysanthes* Raf. and the arising of several problems of interpretation, it seems desirable to consider this genus rather fully. The following key distinguishes all species that I have seen from New Guinea.

- A. Capsule globose to ellipsoid-ovoid, not or only slightly exceeding the calyx; anterior filaments bearing anthers.
- B. Sepals united about $\frac{2}{3}$ their length, glabrous.....1. *L. crustacea*.

⁵"*Gratiola (goodenifolia)* foliis obovato-lanceolatis inciso-serratis basi integerrimis, racemis terminalibus."

- BB. Sepals distinct nearly to base.
- C. Leaf-blades oval to ovate, crenate-serrate to nearly entire, rounded or subcordate at base; bracts oval, the flowers axillary; capsule semiglobose; corolla 9–10 mm. long; sepals and angles of stem hirsute with long non-glandular hairs, the divaricate pedicels nearly glabrous.....2. *L. hirta*.
- CC. Leaf-blades ovate to nearly oblong, serrate-dentate; bracts subulate, the flowers in evident racemes; capsule ellipsoid-ovoid to ovoid; corolla 3–5 mm. long; pedicels glandular-puberulent or -pubescent.
- D. Sepals hirsute with mostly glandless hairs; entire surface of stem and leaves hirsute with spreading glandless hairs, the main blades usually 3–6 cm. long and narrowed at base, only the uppermost rounded-cordate and sessile.....3. *L. viscosa*.
- DD. Sepals sparsely glandular-puberulent to glabrous; angles of stem sharp and with ascending short and stiff glandular hairs; leaf-blades glabrate (except for such lines on main veins beneath), usually narrower and smaller (1–2 cm. long), only the lower narrowed at base, the others rounded to sessile bases.....4. *L. papuana*.
- AA. Capsule much longer than wide, much exceeding the sepals, which are distinct nearly to base.
- B. Leaf-blades sessile or clasping; corolla 5–10 mm. long; stems ascending or erect, often rooting at lower nodes.
- C. Blades ovate to lance-ovate, crenate, rounded or cordate at base; anterior filaments anther-bearing; corolla 10 mm. long.....5. *L. cordifolia*.
- CC. Margin of blades oblong to oblanceolate, usually narrowed at base; anterior filaments without anthers; corolla smaller.
- D. Margin of blades crenate to dentate, the teeth appressed and not prolonged; corolla 7–8 mm. long.....6. *L. anagallis*.
- DD. Margin of blades sharply and deeply serrate, the teeth spreading and prolonged into setaceous tips; corolla 5 mm. long.....7. *L. ciliata*.
- BB. Leaf-blades petioled, elliptic, sharply serrate, but the teeth not setaceous-tipped; corolla 13–15 mm. long; anterior filaments without anthers; stems extensively repent, the flowering portions abruptly erect.....8. *L. antipoda*.

1. *Lindernia crustacea* (L.) F. v. Muell.

This widespread tropical weed, cited by Schlechter (l. c. 106) and me (in Brittonia **2**: 181. 1936, in Jour. Arnold Arb. **20**: 79. 1939) from many localities throughout New Guinea, is among Mrs. Clemens' recent collections from Morobe; there are also several collections made by Netherlands botanists in western New Guinea at the Gray Herbarium.

2. *Lindernia hirta* (Cham. & Schlecht.) comb. nov.

Gratiola pusilla Willd. cur. L. Sp. Plant. ed. 4. **1**: 105. 1797. "Habitat in India ad scaturigines." Descriptive of a small plant of the species now considered. Basis of *Lindernia pusilla* (Willd.) Schlechter in Bot. Jahrb. **59**: 106. 1924, unfortunately preoccupied by *L. pusilla* (Thunb.) Merr. in Philip. Jour. Sci. Bot. **11**: 312. 1916 [1917]. Although intended for the present species and citing *Gratiola pusilla* Willd. as a synonym, the latter was based upon *Selago pusilla* Thunb. Prod. Plant. Cap. 99. "1794–1800," the part containing p. 99 actually published in 1800; Thunberg's brief diagnosis "S. foliis ovatis serratis pilosis, flore terminali subsolitario" is impossible for our plant, as this has leaf-blades crenate to entire and an inflorescence of several pairs of long-pedicelled flowers, while its occurrence is far from South Africa.

Torenia hirta Cham. & Schlecht. in Linnaea **2**: 571. 1827. "E. Luconia retulimus"; collected by Chamisso & Eschscholtz on the Romanzoff Expedition. Clearly the species now considered.

Vandellia scabra Benth. Scroph. Indicae 36. 1835. The name long applied to this species.

Recorded by Schlechter (l. c. 107) from the Bismarck Archipelago, and recently collected at Boana, Morobe District, Northeastern New Guinea, by Mary S. Clemens, no. 41468a (Mich); also at Balim River, Netherlands New Guinea, by L. J. Brass, no. 11821 (AA, ANSP).

*3. *Lindernia viscosa* (Hornemann) Boldingh, Zakfl. Landbouwstr. Java 165. 1916, nomen; Merrill, Enum. Philip. Fl. Pl. 3: 439. 1923, cum syn.⁶

Gratiola viscosa Hornemann, Enum. Pl. Hort. Hafn. 19. 1807. Description seen as quoted in account of *Hornemannia viscosa* (Hornem.) Willd. Enum. Pl. Hort. Berol. 654, 1809, where its habitat was given as "in India orientali." Descriptive of the species now considered in its leaves serrate and hispid, the uppermost cordate and sessile, the flowers racemose and decussate, and the peduncles viscid. On this we can only assume that *Lindernia viscosa* Boldingh was based; Merrill independently made the transfer in 1923, adding the name-bringing synonym.

Vandellia hirsuta Buch. Ham. ex Benth. Scroph. Indicae 36. 1835. The specific epithet long applied to this species, and more appropriate in its allusion to the copious hairiness rather than to the obscure glandularity.

A common Indo-Malayan species occurring east to western New Guinea, as shown by specimens in the Gray Herbarium from Manokoeari (*R. F. Janowsky* 502) and Piorienbivak near the Mamberamo River (*H. J. Lam* 509), Netherlands New Guinea.

*4. *Lindernia papuana* sp. nov. PLATE I, A.

Herba annua, 0.5–1 dm. longa, ramosissima; caulis quadrangulatus, angulis hispidulus; folia oblongo-ovata, acuta, serrato-dentata, glabrata (subtus proxime venis hispidula), laminis 1–2 cm. longis, 6–8 mm. latis,

⁶In Boldingh's "Zakflora voor de Landbouwstreken op Java," Batavia, i–viii. 1–204, October, 1916, a number of new binomials appear in his key to the families, genera, and species but in no case are these names indicated as new, nor in any case is a name-bringing synonym given; they are merely followed by the abbreviation "Bold.," and appear in the work only as follows:

"Bloeiwijze bijna geheel zonder bladen.....*Lindernia viscosa* Bold.

Bloemen in de bladokzels van goed ontwikkelde bladen....*Lindernia pusilla* Bold."

In so far as Boldingh's binomials were actually new, they were entered in Index Kewensis, Suppl. 9, 1935. Those in the Scrophulariaceae are *Ilysanthes procumbens* Bold. p. 164, and *Lindernia viscosa* Bold., *L. pusilla* Bold., *Microcarpaea minima* Bold., and *Stemodia verticillata* Bold. p. 165. It is manifest that Boldingh attempted to detect and to use the earliest published specific name in each case that was valid under the generic names accepted by him, but it is most unfortunate that he failed to indicate the original sources of these names. Strictly in accordance with the rules it is doubtful if these Boldingh names of 1916 should be accepted as validly published, due to their presentation in a most unorthodox manner. His method of publication transcends the provision of the International Code of Botanical Nomenclature that requires, in transferring specific names from one genus to another, that the name-bringing synonym must be cited. They may be considered as illegitimate names, but in view of the fact that they are now listed in Index Kewensis, Suppl. 9, 1938, sometimes with the name-bringing synonym added, it does seem desirable to accept them and to complete the record as has been done in this case. To complete the record in all cases will be difficult, for in the case of *Lindernia pusilla* Bold., who can say whether it was his intent to base this on *Gratiola pusilla* Willd. (1797), or on *Selago pusilla* Thunb. (1800), or on both? The Willdenow and Thunberg entities are actually two entirely different species; the first is a *Lindernia*, but the second apparently does not belong in this genus. As published by me in 1916 [1917], *Lindernia pusilla* Merr. must be typified by *Selago pusilla* Thunb., and the entry in Index Kewensis, Suppl. 9, 1938, for the combined Boldingh-Merrill transfers cites Thunberg's name as the one synonym. — E. D. Merrill.

basi rotundatis, sessilibus; racemus terminalis, florum 3–7 paribus compositus, sparse glandulari-puberulentus; bracteae subulatae; pedicelli 5–8 mm. longi, adscendentes; sepala 2.5 mm. longa, lineari-lanceolata, acuta, glabrata; corolla 3–4 mm. longa, alba, glabra, labio superno rotundato fere integro, labio infero trilobato, lobis triangulari-ovatis; stamina glabra, omnia antherifera; capsula 2.5 mm. longa, ellipsoideo-ovoidea, glabra; semina 0.25 mm. longa, flava, cylindrica, truncata, obsolete reticulata.

Low much-branched herb. Stems diffusely ascending, 0.5–1 dm. long, four-angled, the angles slightly winged and bearing ascending short stiff glandless hairs. Leaf-blades oblong-ovate, serrate-dentate, obscurely and callosely ciliate, glabrate, beneath slightly paler and proximally with veins somewhat stiff-pubescent, mostly 1–2 cm. long, 6–8 mm. wide, rounded to sessile bases, only the lower attenuate proximally. Inflorescence a raceme of 3 to 7 pairs of flowers, the rachis and pedicels sparsely glandular-puberulent, the latter ascending, 5–8 mm. long; bracts (above the short wide lowermost one) subulate, 0.5–1.5 mm. long. Sepals 2.5 mm. long, linear-lanceolate, acute, minutely and obscurely pilose to glabrous. Corolla 3–4 mm. long, white, glabrous, the tube slightly widened horizontally, anteriorly 2-ridged; upper lip scarcely retuse at the truncately rounded apex, the lower slightly longer, the lobes triangular-ovate, widely deflexed-spreading. All filaments antheriferous, the posterior short, ascending, the anterior forming by their attachment the antero-lateral ridges of the corolla that distally project as minute rounded knobs, the free distal portions of the filaments arched-ascending. Capsule 2.5 mm. long, ellipsoid-ovoid, glabrous. Seeds 0.25 mm. long, yellow, cylindric, truncate, obsoletely reticulate.

NORTHEASTERN NEW GUINEA: Morobe District, Kajabit Mission, alt. about 300 m., Mary S. Clemens 10907 (ANSP, TYPE, AA), Dec. 25, 1939, in flower and fruit (forming loose spreading mats along margin of slow rivulet). NETHERLANDS NEW GUINEA: Near Pioniorbivak, alt. 60 m., region of Mamberamo River, H. J. Lam 511 (GH).

In Schlechter's account this was called *Lindernia trichotoma* (Benth.) Schlechter, based upon *Tittmannia trichotoma* Benth. in Wall. Numer. List no. 3943. 1831, a *nomen nudum*. That would be identical with the Indian species long known as *Vandellia multiflora* (Roxb.) G. Don, based upon *Torenia multiflora* Roxb. Fl. Ind. 3: 96. 1832, a plant described as with smooth stem and merely subserrate leaves, agreeing with J. D. Hooker's statement that the leaves of the Bengal plant are entire or sinuate. Evidently the Papuan plant, with its stiffly hairy stem and rather sharply serrate-dentate leaves, cannot be this, nor do I identify it with any other known species.

5. *Lindernia cordifolia* (Colsmann) Merrill.

Gratiola cordifolia Colsmann, Prodr. Descr. Grat. 15. 1793; repr. in Archiv Bot. 2: 244. 1799. "Habitat in graminosis humidiusculis Zeylon[a]e [a D. König collecta]." Leaf-blades described as "obsolete serratis."

The plant, represented by *Brass* 5918, from Dagwa, Oriomo River, British New Guinea, appears to be this well-known Indo-Malayan species rather than *Lindernia angustifolia* (Benth.) Wettst., as identified by me in Brittonia 2: 182. 1936.

6. *Lindernia anagallis* (Burman f.) comb. nov.

Ruellia anagallis Burman f. Fl. Ind. 135. 1768. "Habitat in Java and Amboina."

Based upon plants collected in Java by Kleinhof and on Rumphius' description and illustration of the Amboina form, the latter because of the illustration being taken as the type. Unfortunately, the Academy lacks vol. 5 of Rumphius' Herbarium Amboinense, but Merrill's Interpretation of that work (p. 467, 1917) has identified Rumphius' plant as the species now considered. Also, Dr. Merrill has kindly supplied me with a tracing of Rumphius' figure. In a special paper on the species proposed by Burman f. (in Philip. Jour. Sci. **19**: 381, 1921), he says of *Ruellia anagallis*: "Burman's species is clearly identical with the very common and widely distributed form currently known as *Bonnaya veronicaefolia* Spreng." (As will be shown below, I think that Merrill was mistaken in identifying as this plant the older *Ruellia antipoda* L.; nor is it *Gratiola veronicifolia* Retz., either).

A common Indo-Malayan weed, extending east to New Guinea. This is the plant called *Ilysanthes veronicaefolia* (Retz.) Urb. by Schlechter (l. c. 108), who cites specimens from many parts of New Guinea, while I (in Brittonia **2**: 182, 1936, in Jour. Arnold Arb. **20**: 81, 1939) have cited further specimens from British New Guinea under the names "*veronicaefolia*" and "*antipoda*." Further collections are now at hand, viz. *Clemens 10830a* and *40615* (Mich) from the Morobe District of Northeastern New Guinea, and several specimens (GH) made by Netherlands collectors in western New Guinea.

7. *Lindernia ciliata* (Colsmann) comb. nov.

Gratiola ciliata Colsmann, Prodr. Descr. Grat. 14. 1793; repr. in Archiv Bot. **2**: 243. 1799. "E. Java. *Königius* non invenit." An excellent description of the species now considered.

A common Indo-Malayan plant that appears barely to reach New Guinea. This was reported by Schlechter (l. c. 109) as *Ilysanthes ciliata* from "Waighiou" Island, on the northern shore of Netherlands New Guinea.

8. *Lindernia antipoda* (L.) Alston.

Ruellia antipoda L. Sp. Pl. 635. 1753. "Habitat in Indiis." Based primarily upon account in L. Fl. Zeyl. 106. 1748. The latter careful description states that the leaves are oval, acutely and deeply serrate especially toward apex, at base narrowed, the stem is repent, the pediceled flowers several (5) to a raceme, the capsule thrice as long as the calyx, and the flowers relatively large (being like those shown in Rheede's Hort. Malabar. **9**: 113. *tab. 58*. 1689, but four times larger). All these details are clearly distinctive of the species now considered.

Gratiola veronicifolia Retz. Observ. Bot. **4**: 8. 1786. Clearly identical with *Ruellia antipoda*, as was recognized by Vahl, Enum. Plant. **1**: 98. 1805.

Gratiola ruellioides Colsmann, Prodr. Descr. Grat. 12. 1793; repr. in Archiv Bot. **2**: 243. 1799. "Habitat in Java et India orientali." Clearly distinctive of the species now considered. The name chosen leads me to suppose that Colsmann realized the identity of this with *Ruellia antipoda*. Based upon this is *Ilysanthes ruellioides* (Colsmann)⁷ Schlechter in Bot. Jahrb. **59**: 109. 1924, the name used by him for the species now considered.

Gratiola reptans Roxb. Fl. Ind. cur. Carey **1**: 140. 1820. "A native of the Moluccas; from thence introduced into the [Calcutta] Botanic Garden." Descriptive of the species now considered, and giving the color as corolla "pale bluish pink," upper lip "of one pale segment," and lower lip as "broad, deeper coloured." *Bonnaya reptans* (Roxb.) Spreng., based upon this, has been the name longest used for this species.

A common Indo-Malayan weed, extending east to New Guinea. Re-

⁷With citation of "König" rather than "Colsmann."

ported by Schlechter (l. c. 109) from Netherlands and Northeastern New Guinea, and by me (in Jour. Arnold Arb. **20**: 81. 1939) from British New Guinea. Recently collected by Mrs. Clemens, at Wantoal, no. 41093 (AA), and at Boana, no. 41083 (Mich), both in the Morobe District of Northeastern New Guinea.

8. *Torenia* Linnaeus

This extensive Oriental genus is represented by at least three species in New Guinea.

Although a sharp line between *Lindernia* (in its present enlarged sense) and *Torenia* is not easy to draw, I think that the two should be considered as generically distinct. Usually they are readily distinguishable by the calyx consisting of separate or only slightly united plane sepals in *Lindernia*, whereas in *Torenia* the sepals are united nearly throughout and have the midvein of each raised into a ridge or a wing. But, in *Lindernia*, *L. crustacea* has sepals united over half their length, while in *Torenia* the sepal-ridges may be mere ribs, as in the case of *T. crenata*, below. In *Torenia* the corolla is usually larger and with angular open throat, whereas in *Lindernia* it is usually smaller and with flattened throat. Finally, in *Torenia* one finds in most species a racemose inflorescence or one contracted therefrom, in which the bracts are linear and much smaller than the foliage leaves, whereas in *Lindernia* the bracts are usually foliose. In our first species, *Torenia crenata*, the small flowers, unwinged calyx, and foliose bracts all led me to consider it a *Lindernia*, but I now incline to place generic value on another feature of the calyx. In *Lindernia* the sepals, whether distinct or joined, do not invest the capsule, but have their tips somewhat spreading, whereas in *Torenia* the sepals do invest the capsule, being curved about it and with their connivent tips projecting above it. On this understanding our first species will find its place in *Torenia*. It shows that in that genus too there is a tendency toward the suppression of the anthers of the anterior pair of stamens.

- A. Calyx hirsute, the mid-veins of the sepals merely rib-like; corolla 7–8 mm. long, violet; attached portions of anterior filaments projecting as short knobs; pedicels over twice the length of the calyces; bracts foliaceous, the inflorescence clearly racemose; leaf-blades crenate, cuneately narrowed to the short petioles; stem erect, with ascending branches. 1. *T. crenata*.
- AA. Calyx finely pubescent or glabrous, the mid-veins of the sepals raised into thin wings; corolla larger; attached portions of anterior filaments not projecting; pedicels less than twice the length of the calyces; bracts subulate, the inflorescence (by suppression of an internode) usually seeming a 4-flowered cyme; leaf-blades dentate, the larger truncate to petioles at least $\frac{1}{3}$ length of blades.
 - B. Corolla 15–17 mm. long, violet or white; fruiting calyx narrowly ovoid, 15–16 mm. long, with 5 wings; leaf-blades acute, serrate-dentate, 3–4 cm. long; stem erect, laxly branched. 2. *T. violacea*.
 - BB. Corolla 10 mm. long, pink; fruiting calyx nearly circular, 6–8 mm. long, with 3 wings; leaf-blades obtuse, crenate-dentate, 1–2 cm. long; stem extensively repent, the flowering branches ascending or erect. . . . 3. *T. polygonoides*.

1. *Torenia crenata* (Pennell) comb. nov. PLATE I, B.

Lindernia crenata Pennell in Jour. Arnold Arb. **20**: 79. 1939. Lake Daviumbu,

Middle Fly River, British New Guinea, *L. J. Brass* 7824. Known only from the original collection.

2. ***Torenia violacea*** (Azaola) comb. nov.

Mimulus violaceus Azaola ex Blanco, Fl. Filip. ed. 2. 357. 1845. "Descubierta y descrita por el Sr. Azaola, ex Calauan." For identification of the species now considered see Merrill, Species Blancoanae 347. 1918. Although not adopted by Merrill, his evidence makes it necessary to take this as the earliest described name.

Torenia exappendiculata Regel in Acta Hort. Petrop. 5: 271. 1877. "Ex horto Parisiensi accepimus. Patria verosimiliter India orientalis." Described as with small white flowers.

Torenia peduncularis Benth. in Wall. Numer. List, no. 3956. 1831, *nomen nudum* ("Maulmyne in Martabanica 1827"); Hook. f. Fl. Brit. Ind. 4: 276. 1884. The latter cites specimens from Nepal to Assam and Penang, and credits the species also to Java and the Philippine Islands. Flowers described as "pale blue," but with white-flowered synonym, *T. alba* Ham., from Wallich's List. *Torenia peduncularis* is the name under which our species has been universally known.

A weedy plant, widespread over the Indo-Malayan subregion, and doubtfully extending east to New Guinea. Reported by Schlechter (l. c. 104) from Netherlands and Northeastern New Guinea; a single collection from the vicinity of Manokoeari, Netherlands New Guinea (*R. F. Janowsky* 506), is in the Gray Herbarium. This, however, is a small plant, less than 1 dm. tall, more hairy, with smaller, narrower, more closely serrate leaf-blades, and smaller corollas (10–12 mm. long) and calyces (11–12 mm. long). Perhaps it will prove distinct from the Indo-Malayan species, as is suggested by Schlechter's comment that it seldom exceeds 1.5 dm. in height, a small stature for *T. violacea*. The only other specimen seen associable with it is from Bali (*C. R. G. J. van Steenis* 7588), at the Gray Herbarium. The problem can be solved only by someone with much more material for consideration than is available in this country.

3. ***Torenia polygonoides*** Benth.

Torenia polygonoides Benth. in Wall. Numer. List, no. 3897. 1830, *nomen nudum* ("Singapur 1822"), Scroph. Indicae 39. 1835. "Hab. ad Singapore, Wallich."

A widespread Indo-Malayan species. Reported by Schlechter (l. c. 104) from Northeastern and by me (in Jour. Arnold Arb. 20: 78. 1939) from British New Guinea.

9. ***Detzneria*** Schlechter

(Genotype, *D. tubata* Diels, of New Guinea)

A monotypic genus of Northeastern New Guinea.

1. ***Detzneria tubata*** Diels in Bot. Jahrb. 62: 491. 1929.

Saruwaket Range, Northeastern New Guinea, at 3600 to 4000 meters altitude.

10. ***Hebe*** Commerson

This austral genus, so highly developed in New Zealand, is evidently one of the most characteristic groups of alpine heights in New Guinea. With the first species published in 1889 and only four described before 1930 the Archbold Expeditions have raised the number from New Guinea to twelve. Many more will appear as other alpine areas are reached, as

each isolated highland has evidently developed its own species. The following key contrasts those known to date.

- A. Leaf-blades serrate-dentate, the teeth obtuse or acutish; petioles more spreading; pubescence of stem and inflorescence of upcurved hairs.
 - B. Serrations spreading, the leaf-blades sharply toothed; peduncles 10–30 mm. long, less than twice length of bracts; sepals lanceolate to narrowly ovate, somewhat pubescent; corolla red or reddish.
 - C. Corolla red, its lobes as wide as or wider than long; sepals elliptic-ovate; peduncles spreading; leaf-blades narrowly elliptic, 1.5–2 cm. long, on evident spreading petioles; rachis and pedicels pubescent with upcurved brown hairs.....1. *H. rubra*.
 - CC. Corolla pale pink, its lobes longer than wide; peduncles ascending; sepals and leaf-blades elliptic-lanceolate, 0.5–1 cm. long, on ascending petioles; rachis and pedicels pubescent with upcurved brownish or grayish hairs.....2. *H. thymelaoides*.
 - BB. Serrations ascending or appressed, the leaf-blades more obscurely toothed; leaves loosely set, the blades not or only slightly longer than the internodes; peduncles ascending, 30–50 mm. long, 2 to 4 times the length of the bracts; sepals narrowly obovate-elliptic to elliptic, glabrous; corolla white.....3. *H. albiflora*.
- AA. Leaf-blades crenate-serrate to entire, the teeth rounded.
 - B. Leaf-blades oval to elliptic-oblong, evidently crenate-serrate or crenate.
 - C. Rachis and pedicels with brown spreading hairs; petioles very short and wide, ascending against stem;⁸ leaves not glutinous.
 - D. Corolla and sepals externally pubescent; leaves lanceolate- to orbicular-ovate, 0.8–1.5 cm. long.....4. *H. Lendenfeldii*.
 - DD. Corolla externally glabrous; sepals glabrous or ciliate.
 - E. Corolla pinkish or white, 8–14 mm. long; peduncles 20–40 mm. long, the rachis elongating; leaf-blades flat.
 - F. Sepals partially ciliate to usually glabrous; pedicels equaling or longer than the bractlets; leaf-blades elliptic to elliptic-oblong, 7–16 mm. long; stem distally and inflorescence rufous-pubescent.
 - G. Racemes mostly 5–10-flowered, the pedicels short in small-fruited forms, becoming 15–18 mm. long in large-fruited forms; capsule no wider than long, its narrow basal portion flattened-constricted; leaf-blades crenate-serrate about $\frac{2}{3}$ their length, the midrib evident.....5. *H. polyphylla*.
 - GG. Racemes fewer-flowered, the pedicels to 9 mm. long; capsule wider than long; leaf-blades crenate beyond the middle, the midrib scarcely evident.....6. *H. carstensensis*.
 - FF. Sepals ciliate throughout; pedicels shorter than the bractlets; leaf-blades oval or elliptic, 6–9 mm. long; stem and inflorescence more finely pubescent and with paler hairs.....7. *H. ciliata*.
 - EE. Corolla dark purple, 7–8 mm. long; racemes 1–3-flowered; peduncles 5–12 mm. long, the rachis short, the pedicels reaching 5–7 mm. long; capsule obovoid, rounded to base; leaf-blades crenate-serrate above the cuneate base, somewhat involute.....8. *H. rigida*.
 - CC. Rachis and pedicels with ascending or appressed hairs; leaves glutinous (at least in *H. Brassii* and *H. tenuis*).
 - D. Hairs of inflorescence brown, upcurved-ascending; sepals ciliate and pubescent on midrib externally; corolla red, 9–10 mm. long; leaf-blades 0.7–0.9 cm. long, the petioles very short, ascending-appressed, ciliate; stems stout, erect, 2–3 dm. tall, the leaves as long as the internodes.....9. *H. Brassii*.

⁸This assumed to be probably true for *Hebe Lendenfeldii*, described as with leaves "on very short stalks," and for *H. carstensensis* with leaves "sessile."

DD. Hairs of inflorescence grayish, minute, incurved-appressed;⁹ sepals minutely ciliate; leaf-blades 0.6–0.7 cm. long, the petioles more evident, ascending-spreading, glabrous; stem slender, diffuse, smaller, the leaves shorter than the internodes.

E. Corolla white, 6–7 mm. long; flowers several, in a pair of long-peduncled racemes at the apex of the uniformly finely pubescent stem.....10. *H. tenuis*.

EE. Corolla purple (magenta), 8–9 mm. long; flower solitary¹⁰ at the apex of the bifariously puberulent stem.....11. *H. Vanderwateri*.

BB. Leaf-blades narrowly lanceolate, obscurely crenulate to nearly entire; corolla 12 mm. long; stems and branches densely foliose, shortly and densely pubescent.....12. *H. diosmoides*.

1. *Hebe rubra* Pennell in Brittonia 2: 184. 1936. PLATE II, A.

BRITISH NEW GUINEA: Mt. Albert Edward, *L. J. Brass* 4295 (TYPE) and 5677; Murray Pass, Wharton Range, *Brass* 4620.

2. *Hebe thymelaecoides* Pennell in Brittonia 2: 186. 1936. PLATE II, B.

BRITISH NEW GUINEA: Mt. Albert Edward, *L. J. Brass* 4296 and 4297 (TYPE).

*3. *Hebe albiflora* sp. nov. PLATE III, A.

Frutex ramosissimus, 6–9 dm. altus; caulis pilis adscendentibus-incurvis brunneus; folia oblongo-lanceolata, acuta, serrato-dentata, fere glabra, subtus pallida, majora 2 cm. longa, 7–8 mm. lata; racemi 6–8 floribus compositi; sepala 4–4.5 mm. longa, elliptico-oblancheolata, glabra; corolla 7–8 mm. longa, alba, late campanulata, glabra; capsula 4 mm. longa, globoso-ovoidea; semina 0.5 mm. longa, circularia, laevia, complanata.

Stiff, much-branched shrub, 6–9 dm. tall, loosely foliose. Stem distally pubescent with brownish upcurved hairs, the old bark becoming glabrate. Leaves numerous, not or only slightly longer than the internodes, the blades oblong-lanceolate, acute, serrate-dentate throughout with low teeth, flat, dark green and glabrous above, beneath pale and with pilose midrib, 2 cm. long, 7–8 mm. wide, at base rounded to pubescent petioles 2–3 mm. long. Racemes brown-pubescent (with incurved hairs), 6–8-flowered, elongated, the peduncle becoming 30 to 50 mm. long, the pedicels 5–8 mm. long, slightly exceeding the lance-oblong bractlets. Sepals 4–4.5 mm. long, elliptic-oblancheolate, acute, glabrous. Corolla 7–8 mm. long, white, widely campanulate, glabrous throughout, the upper lip obovate-circular, the three lower lobes slightly narrower, nearly elliptic. Stamens glabrous throughout, the anthers about half the length of the filaments. Capsule 4 mm. long, globose-ovoid. Seeds 0.5 mm. long, circular, flattened, brown.

NORTHEASTERN NEW GUINEA: Morobe District, Ulap Trail, Matap, alt. 1500–1800 m., *Mary S. Clemens* 11347 (AA, TYPE), Feb.–April 1940, in flower.

4. *Hebe Lendenfeldii* (F. v. Muell.) Pennell in Brittonia 2: 184. 1936.

Based upon *Veronica Lendenfeldii* F. v. Muell. in Trans. Roy. Soc. Victoria 1(2): 29. 1889, describing a plant collected by Sir William MacGregor in 1889 on Mt. Victoria in British New Guinea.

*5. *Hebe polyphylla* sp. nov. PLATE III, B.

Frutex ramosissimus, 2–8 dm. altus; caulis pilis patentibus ferrugineus; folia multa, elliptico-oblonga, obtusa, crenato-dentata, glabra, majora 0.7–1.6 cm. longa, 5–7 mm. lata; racemi 5–10 floribus compositi; sepala

⁹Pedicels of *Hebe Vanderwateri* described as "fein bestäubt."

¹⁰"Semper?", asks Wernham.

4–5 mm. longa, oblonga, irregulariter ciliata; corolla 8–11 mm. longa, alba, late campanulata, glabra; capsula 2–4 mm. longa, obovoidea.

Stiff, much-branched shrub, 2–8 dm. tall, the upper branches ascending, densely foliose, the lower slender, diffusely spreading, with longer internodes and pairs of minute subulate leaves. Stem distally pubescent with ferruginous spreading hairs, below that bifariously so but on the proximal half glabrate or glabrous. Leaves numerous, and close-set by reason of the short internodes, the lower stem marked by the slightly raised petiole-rudiments of the fallen leaves: blades elliptic-oblong, obtusely rounded, crenate-dentate, flat, glabrous, 0.7–1.6 cm. long, 5–7 mm. wide, at base semi-petiolate (cuneately narrowed with entire ciliate margins) to a clasping base. Racemes brown-pubescent, 5–10-flowered, elongated, the peduncle becoming 20 to 40 mm. long, the pedicels 3–18 mm. long, about equaling to much longer than the linear-oblong bractlets. Calyx spongy (as judged by irregular wrinkling in drying) at base, the sepals (free above base) oblong, rounded, irregularly ciliate (mostly at apex), 4–6 mm. long. Corolla 8–15 mm. long, white, pinkish-tinged, widely campanulate, glabrous throughout, the upper lip nearly circular, the three lower lobes obovate-semicircular. Stamens glabrous, the anthers about $\frac{1}{3}$ the length of the filaments. Capsule 2–6 mm. long, obovoid.

NETHERLANDS NEW GUINEA: 5 miles northeast of summit of Mt. Wilhelmina, alt. 3440 m., *L. J. Brass* 9401 (AA, TYPE, ANSP), Aug. 1938, in flower and fruit (along streams in grassland); Snow Mountains, on and near Mt. Wilhelmina (seen also from 3 miles east of that summit), *Brass* 9414 (AA, ANSP), and 7 km. northeast of summit, *Brass & Myer-Drees* 9934 (AA, ANSP).

6. *Hebe carstensensis* (Wernham) Diels in Bot. Jahrb. **62**: 491. 1929.

Based upon *Veronica carstensensis* Wernham in Trans. Linn. Soc. II. Bot. **9**: 121. 1916, describing a plant collected by C. Boden Kloss in 1912–13 on Carstensch Peak, Snow Mountains (Nassau Range), Netherlands New Guinea.

*7. *Hebe ciliata* sp. nov. PLATE IV, A.

Frutex ramosus, 2–6 dm. altus; caulis pilis brevibus patentibus brunneus; folia multa, ovalia vel inferiora elliptica, obtusa, crenato-dentata, glabra glabratave, majora 0.6–0.9 cm. longa, 5–7 mm. lata; racemi 4–8 floribus compositi; sepala 4–5 mm. longa, obovato-oblonga, ciliata; corolla 7–8 mm. longa, pallide violacea vel alba, late campanulata, glabra; capsula 2–3 mm. longa, obovoidea.

Stiff shrub, 2–6 dm. tall, the rigid stems ultimately erect, the upper branches ascending-erect and densely foliose, the lower slender, diffusely spreading, with longer internodes and pairs of minute subulate leaves. Stem pubescent with short brown spreading hairs, proximally glabrescent or glabrate. Leaves numerous and close-set (the short internodes of the lower part of the stem marked as in the other species), the blades oval or the lower elliptic, obtusely rounded, crenate-dentate, flat, glabrous (or sometimes pubescent beneath on the obscure midrib), 6–9 mm. long, 5–7 mm. wide, at base widely cuneate to the ill-defined short entire ciliate petioles. Racemes brownish-pubescent, 4–8-flowered, elongated, the peduncle becoming 20–25 mm. long, the pedicels 2–5 (–7) mm. long, mostly shorter than the obovate-oblong bractlets. Calyx spongy at base, the sepals 4–5 mm. long, obovate-oblong, obtusely rounded, ciliate throughout.

Corolla 7–8 mm. long, pale violet-purple to white, widely campanulate, glabrous throughout, the upper lip nearly circular, the three lower lobes nearly as large. Stamens glabrous, the anther less than half the length of the filament. Capsule 2–3 mm. long, obovoid.

NETHERLANDS NEW GUINEA: Mt. Wilhelmina, alt. 3400 m., *L. J. Brass & E. Meyer-Drees* 9682 (AA, TYPE, ANSP), Sept. 1938, in flower and fruit (rather wet grassy place along a small river, the whole plant apparently somewhat violet-tinged, the corolla being pale violet within and nearly white externally); Mt. Wilhelmina, alt. 3900–4250 m., alpine grassland, northern slopes, *Brass & Meyer-Drees* 10092, 10094 (both AA, ANSP), southern slopes, *Brass & Meyer-Drees* 10098, 10101, 10104 (all AA, ANSP). No. 10092 differs from the others in the ciliation of the sepals being shorter and partial (as in other species), but the leaf-blades are oval as in *H. ciliata*. No. 10094 is said to be "common on old rock screes," and no. 10101 "plentiful on rocky limestone slopes."

*8. *Hebe rigida* sp. nov. PLATE IV, B.

Frutex ramosissimus, rigidus; caulis pilis brevibus patentibus pubescens; folia multa, oblongo-elliptica, obtusa, crenato-dentata, glabra, majora 0.5–0.7 cm. longa, 3–4 mm. lata; racemi 1–3 floribus compositi; sepala 4–5 mm. longa, anguste oblonga, glabra; corolla 7–8 mm. longa, atropurpurea, late campanulata, glabra; capsula 4 mm. longa, obovoidea.

Stiff shrub, 2–4 dm. tall, with many rigidly erect stems from the slightly spreading rhizomatous base, these distally with many ascending-erect blackish purple branches. Stem pubescent with short spreading hairs, tardily glabrescent below. Leaves numerous and close-set (the short internodes of the lower part of the stem marked as in the other species), the blades oblong-elliptic, obtuse, crenate-dentate, glabrous (with hardly evident midrib), 5–7 mm. long, 3–4 mm. wide, at base cuneate to the ill-defined short entire ciliate petioles, both blades and petioles involutely hollowed. Racemes pubescent with short hairs, 1–3-flowered, short, the peduncle 4–12 mm. long, the pedicels 3–5 mm. long, shorter than or equaling the linear-oblong bractlets. Calyx not spongy at base, the sepals 4–5 mm. long, narrowly oblong, obtusely rounded, the margin entire and glabrous. Corolla 7–8 mm. long, dark purple, widely campanulate, glabrous throughout, the upper lip nearly circular, the three lower lobes similar and nearly as large. Stamens glabrous, the anthers less than half the length of the filaments. Capsule 4 mm. long, obovoid.

NETHERLANDS NEW GUINEA: Northern slope of Mt. Wilhelmina, alt. 4100 m., *L. J. Brass & E. Meyer-Drees* 10090 (ANSP, TYPE, AA), Sept. 1938, in flower and fruit (common on tussock-grass slopes, often growing in moss-cushions).

9. *Hebe Brassii* Pennell in *Brittonia* 2: 185. 1936. PLATE V, A.

BRITISH NEW GUINEA: Mt. Albert Edward, *L. J. Brass* 4498 (TYPE).

*10. *Hebe tenuis* sp. nov. PLATE V, B.

Suffrutex repens, ramosus, 1–1.5 dm. altus; caulis pilis minutis incurvis pubescens; folia elliptica, rotundata, crenato-dentata, glabra, glutinosa, majora 0.7–0.9 cm. longa, 4–6 mm. lata; racemi 3–7 floribus laxo compositi; sepala 4 mm. longa, oblanceolata vel obovata, glabrata; corolla 7 mm. longa, alba, campanulata, glabra; capsula 4 mm. longa, obovoidea.

Suffrutescent and extensively repent, distally ascending, 1–1.5 dm. tall, laxly branched. Stems finely pubescent with minute incurved hairs, tardily glabrescent below. Leaves shorter than or about equaling the internodes (which are rather longer than those of the erect bushy species, and with nodes as clearly marked), the blades elliptic, rounded at apex,

crenate-dentate, flat, glabrous (with evident midrib), somewhat glutinous, 7–9 mm. long, 4–6 mm. wide, at base cuneate to the short flattened ciliate petioles. Racemes finely appressed-pubescent (with minute incurved hairs), 3–7-flowered, lax, the peduncle becoming 30–40 mm. long, the pedicels 7–10 mm. long, about twice as long as the oblanceolate bractlets. Sepals 4 mm. long, oblanceolate to obovate, rounded, slightly ciliate to glabrous. Corolla 7 mm. long, white, campanulate, glabrous throughout, the upper lip rounded, the three lower lobes slightly smaller, rounded. Stamens glabrous, the anthers about half the length of the filaments. Capsule 4 mm. long, obovoid.

NORTHEASTERN NEW GUINEA: Summit of Mt. Sarawaket, alt. 4100 m., *Mary S. Clemens* 5642 (AA, TYPE), Apr. 8, 1937, in flower (among open grass and shrublets).

11. ***Hebe Vanderwateri*** (Wernham) Van Steenis in Bull. Jard. Bot. Buitenzorg III. 13: 252. 1934.

Based upon *Veronica Vanderwateri* Wernham in Trans. Linn. Soc. II. Bot. 9: 121. 1916, describing a plant collected by C. Boden Kloss in 1912–13 on Carstensz Peak, Netherlands New Guinea.

12. ***Hebe diosmoides*** (Schlechter) Pennell in Brittonia 2: 184. 1936.

Based upon *Veronica diosmoides* Schlechter in Bot. Jahrb. 59: 111. 1924, describing a plant collected by Sir William MacGregor in 1889 on Mt. Victoria in British New Guinea.

11. *Veronica* Linnaeus

Since *Veronica Archboldii* was described seven years ago, several more members of this genus have been noted in collections from New Guinea, all of them similarly pertaining to the group of *V. serpyllifolia* L. From that species and its more cosmopolitan subspecies *humifusa* (Dickson) Vahl these all differ in the less hairy capsules, and, excepting the diminutive *V. platycarpa*, in the relatively wider and more toothed leaf-blades as well. What may be somewhat arbitrarily accounted the species of *Veronica* in New Guinea differ as follows:

- A. Capsule widest about midway of its length, often exceeded by the sepals; racemes becoming many-flowered; leaf-blades elliptic or slightly longer, crenate-dentate; stems 1–4 dm. tall.....1. *V. Archboldii*.
- AA. Capsule widest near the base, exceeding the sepals; racemes few-flowered; leaf-blades oblong-elliptic, crenate-serrate with few teeth; stems less than 1 dm. tall, the whole plant smaller.....2. *V. platycarpa*.

1. ***Veronica Archboldii*** Pennell in Brittonia 2: 182. 1936.

The following, tentatively considered as subspecies, may prove specifically distinct. In all the aspect is similar, and there is equal possibility that further collecting may break down the validity of the characters adduced. Analogous to the wide distribution of *Veronica serpyllifolia* and its subspecies, this is being considered as a single species occurring throughout the mountain ranges of New Guinea. The subspecies yet known may be distinguished as follows:

- A. Sepals about the length of the capsule (slightly shorter to longer than); corolla pale blue or white; pubescence of stem distally and of pedicels consisting of minute ascending-incurved hairs; leaf-blades little longer than wide, more evidently crenate-dentate.....1b. Subsp. *ellipticophylla*.

AA. Sepals much longer than the capsule; leaf-blades with fewer and shallower dentations.

B. Leaf-blades slightly elongated, $1\frac{1}{2}$ –2 times as long as wide; pubescence of minute ascending-appressed hairs; corolla "pale purple, streaked with white."

.....1a. Subsp. *typica*.

BB. Leaf-blades little longer than wide; pubescence of fine spreading hairs; corolla "blue"1c. Subsp. *patulifera*.

1a. ***Veronica Archboldii* subsp. *typica*.**

Veronica Archboldii Pennell in Brittonia **2**: 182. 1936.

BRITISH NEW GUINEA: Mt. Albert Edward, *L. J. Brass* 4403 (TYPE), and Murray Pass, Wharton Range, *Brass* 4941.

*1b. ***Veronica Archboldii* subsp. *ellipticophylla* subsp. nov.**

Caules 2–4 dm. longi, pilis adscendenti-incurvis minute pubescentes; folia elliptica, 0.7–1.5 cm. longa, 5–12 mm. lata; sepala 4–5 mm. longa, oblongo-lanceolata; capsula 3 mm. longa.

Stems widely repent, ascending distally, 2–4 dm. long, finely pubescent with minute ascending-incurved hairs. Leaf-blades elliptic, 7–15 mm. long, 5–12 mm. wide, dentate with low teeth. Pedicels slightly longer than calyces, finely pubescent with incurved-ascending hairs. Sepals oblong-lanceolate, becoming 4–5 mm. long. Corolla pale blue or white. Capsule 3 mm. long, 4 mm. wide, notched $\frac{1}{4}$ depth. Seeds 1 mm. long.¹¹

NETHERLANDS NEW GUINEA: Lake Habbema, north of Mt. Wilhelmina, alt. 3225 m., *L. J. Brass* 9313 (ANSP, TYPE, AA), Aug. 1938, in flower and fruit (on burnt-over ground); 7–11 km. northeast of Mt. Wilhelmina, alt. 3400–3560 m., *Brass & Myer-Drees* 9683, 9749, 9861 (all AA, ANSP), in grass and moss.

This appears to be the prevalent member of this group on and near Mt. Wilhelmina in the Snow Mountains of Netherlands New Guinea.

*1c. ***Veronica Archboldii* subsp. *patulifera* subsp. nov.**

Caules 1–2 dm. longi, pilis patentibus pubescentes; folia elliptica, 0.7–1 cm. longa, 5–7 mm. lata; sepala 4–5 mm. longa, lineari-oblonga; capsula parva.

Stems widely repent, ascending distally, 1–2 dm. long, distally finely pubescent with spreading hairs. Leaf-blades elliptic, 7–10 mm. long, 5–7 mm. wide, dentate with low teeth. Pedicels shorter than or the lower equaling the calyces, finely pubescent with spreading hairs. Sepals linear-oblong, becoming 4–5 mm. long. Corolla "blue." Capsule small, not seen mature (perhaps abnormally atrophied).

NETHERLANDS NEW GUINEA: Northern slope of Mt. Wilhelmina, alt. 4050 m., *L. J. Brass & E. Myer-Drees* 10163 (AA, TYPE, ANSP), Sept. 1938, in flower (on a wet tussock-grass slope).

2. ***Veronica platycarpa* Pennell in Notulae Naturae **23**: 1. 1939.**

Collected by Mary S. Clemens (no. 10120) in 1939 on Mt. Sarawaket, Northeastern New Guinea.

12. ***Sopubia* Buch. Ham.**

One species represented, the Indo-Malayan *S. trifida* Buch. Ham., by *Brass* 4819, from British New Guinea (already reported in Brittonia

¹¹About twice the length of the seeds of *Veronica serpyllifolia* L. and *V. serpyllifolia humifusa* (Dickson) Vahl. This is the only subspecies of *V. Archboldii* of which seeds have been seen.

2: 187. 1936), and *Mary S. Clemens 10736*, recently gathered near the Kajabit Mission in the Morobe District, Northeastern New Guinea.

13. *Centranthera* R. Brown

One species represented, the Indo-Malayan *C. cochinchinensis* (Lour.) Merr., reported by Schlechter in Bot. Jahrb. **59**: 112. 1924 (as *C. hispida* R. Br.), and by me in Brittonia **2**: 187. 1936 (for *Brass 3574 & 5703*) and in Jour. Arnold Arb. **20**: 81. 1939 (for *Brass 7815 & 8270*). All the cited collections are from British New Guinea.

14. *Buchnera* Linnaeus

Schlechter credited only a single species to New Guinea, but, as might be anticipated from the number westward in the Malay Archipelago and southward in northern Australia, there are several. Those now known may be distinguished as follows:

- A. Corolla externally somewhat hairy; inflorescence densely hairy...1. *B. tomentosa*.
- AA. Corolla externally glabrous; inflorescence less hairy.
 - B. Calyx and bracts finely pubescent over entire surface, the calyx not ridged; middle and lower leaf-blades lance-oblong, dentate.....2. *B. urticifolia*.
 - BB. Calyx and bracts hairy on ribs and margins, or else glabrous; middle leaf-blades lanceolate or nearly linear, the lowest wider and dentate.
 - C. Bracts ciliate, at least the upper ovate; calyx finely 10-ribbed, the ribs usually evident by reason of the ascending scabrous hairs, but varying to glabrous; capsule equaling or slightly exceeding the calyx; flowers more than ten, usually approximating to form a rather dense spike...3. *B. ciliata*.
 - CC. Bracts ciliolate, the upper ovate with a caudate tip; calyx not ribbed, glabrous except for minute ciliation of lobes; capsule not seen; flowers less than ten, scattered in an open spike.....4. *B. rariflora*.

1. *Buchnera tomentosa* Blume, Bijdr. Fl. Nederl. Ind. 741. 1825.

Originally described from Java. By Schlechter (l. c. 113) this was considered to be the only species in New Guinea, specimens being cited from Netherlands and Northeastern New Guinea, and from the Bismarck Archipelago. None of these collections have been seen and they may not all fit the concluding note, which characterizes the Papuan plant as differing from *B. urticifolia* in its larger flowers and its stronger hairiness, the hairs being mostly very thick on the rachis of the inflorescence.

NETHERLANDS NEW GUINEA: Morobe District, in grassland, alt. less than 1500 m., Boana, *Mary S. Clemens 41619*; Wantoat, *Clemens 11208, 40864* (flowers varying from white to pink).

2. *Buchnera urticifolia* R. Brown, Prodr. Fl. Nov. Holl. **1**: 437. 1810.

Originally described from the tropical coastland of northeastern Australia, the present Queensland. Occurs in both western and eastern New Guinea, on open grassland at low altitudes.

NETHERLANDS NEW GUINEA: Cyclops Mts., *K. Gjellerup 500* (GH); Merauke, *G. Versteeg 1837* (GH). NORTHEASTERN NEW GUINEA: Morobe District, Kajabit Mission, *Mary S. Clemens*. BRITISH NEW GUINEA: Urunu, *Brass 4821*; Fly River, *Brass 7813*, 8253.¹²

¹²Already reported in Jour. Arnold Arb. **20**: 82. 1939. These are the plants covered by contrast "A" of the key.

*3. *Buchnera ciliata* sp. nov.

Caulis 3–5 dm. altus, laxe pubescens glabratusve, simplex vel pauciramosus; folia scabro-pubescentia, tricostata, integra dentatave, infima fere ovalia et brevia, intermedia majora, saepe oblonga, 4 cm. longa, superiora lineari-lanceolata; spica tenuis, 10–15 paribus florum composita; bracteae 3–4 mm. longae, ovatae, acuminatae, ciliatae; calycis tubus 4 mm. longus, 10-costatus, costis scabro-pubescentibus vel glabris, lobis 1 mm. longis, ovato-lanceolatis, ciliolatis; corolla extus glabra, tubo 6–7 mm. longo ore intus villuloso, lobis oblanceolatis, inferioribus 3–4 mm. longis; capsula 5 mm. longa; semina 0.5 mm. longa.

Stem 3–5 dm. tall, loosely pubescent to glabrate, simple or distally slightly branched. Lowest leaves nearly oval, short, entire or dentate; middle leaves larger and longer, often nearly oblong, about 4 cm. long and 10 mm. wide, obtuse, entire or somewhat dentate; upper leaves linear-lanceolate, 5–6 cm. long, attenuate, the uppermost slightly smaller and slightly more remote, but seemingly continuous nearly or quite to the inflorescence; leaves scabrous-pubescent on both surfaces, 3-ribbed beneath. Spike slender, rather dense (the ascending fruiting calyces nearly or quite contiguous), of 10 to 15 pairs of flowers. Bracts 3–4 mm. long, ovate, acuminate or the upper acute, strongly ciliate (hairs 0.3–0.4 mm. long). Calyx-tube 4 mm. long, finely 10-ribbed, with short ascending scabrous hairs on ribs or sometimes glabrous; lobes 1–1.2 mm. long, ovate-lanceolate, attenuate, obscurely ciliolate. Corolla "pink," externally glabrous, the tube 6–7 mm. long, its orifice finely villose with white hairs, the lobes oblanceolate, truncate or nearly so, the lower longer, reaching 3–4 mm. long, the upper 2–3 mm. long. Capsule 5 mm. long, cylindric, equaling or slightly exceeding the calyx. Seeds about 0.5 mm. long, triangular-conic, brown, obscurely longitudinally lined.

NETHERLANDS NEW GUINEA: Balim River, northeast of Mt. Wilhelmina, alt. 1600 m., *L. J. Brass 11725* (ANSP, TYPE, AA), Dec. 1938, in flower and fruit (occasional on grassy deforested slope); "Zuid Nieuw Guinea pr. O. Kaba," *Branderhorst 89* (GH).

*4. *Buchnera rariflora* sp. nov.

Caulis 5–6 dm. altus, bifariam puberulentus, simplex; folia supra glabra, subtus scabrella, tricostata, fere integra, infima fere ovalia et brevia, intermedia etiam parva, oblongo-lanceolata, 2–2.5 cm. longa, superiora lineari-lanceolata, suprema brevissima et remota; spica tenuissima, circa 3 paribus florum composita; bracteae 3 mm. longae, lanceolato-ovatae, acuminatae, parum ciliolatae; calycis tubus 4 mm. longus, ecostatus, glaber, lobis 1 mm. longis, lanceolato-attenuatis, obscure scabrello-ciliolatis; corolla extus glabra, tubo 6–7 mm. longo ore intus villosulo, lobis oblanceolatis, inferioribus 3–4 mm. longis; capsula non visa.

Stem 5–6 dm. tall, bifariously puberulent, simple throughout. Lowest leaves nearly oval, short, entire or dentate; middle leaves scarcely or not larger, oblong-lanceolate, 2–2.5 cm. long, 5 mm. wide, acute, entire; upper leaves linear-lanceolate, 2–2.5 mm. long, attenuate, the uppermost very short and remote, the inflorescence seeming long-peduncled; leaves above glabrous or slightly scabro-pubescent distally, beneath slightly scabrous, especially on the three ribs. Spike very slender, lax (the calyces less than or barely half length of internodes), of about 3 pairs of somewhat scattered flowers. Bracts 3 mm. long, lance-ovate or the upper ovate, acuminate to slightly caudate, obscurely ciliolate (hairs less than 0.05 mm. long).

Calyx-tube 4 mm. long, not evidently ribbed, glabrous; lobes 1 mm. long, lanceolate-attenuate, obscurely scabrellous-ciliolate. Corolla "pink," externally glabrous, the tube 6-7 mm. long, its orifice coarsely villose with projecting white hairs, its lobes oblanceolate, retuse, the lower longer, reaching 3-4 mm. long, the upper 2-2.5 mm. long. Capsule not seen.

BRITISH NEW GUINEA: Western Division, Tarara, Wassi Kussa River, *L. J. Brass* 8571 (ANSP, TYPE, AA), Dec. 1936, in flower (rare in savanna-forest), *Brass* 8597 (AA, ANSP).¹³

15. *Striga* Loureiro

In this Journal for 1939 (20: 83) I discussed the probability of there being valid color-distinctions between the various species of this genus. This view seems to be sustained by the further collections now reported. Also, as there prove to be objections to using either of the specific names employed by Schlechter for the two species of his enumeration in 1924, it becomes advisable to present a new summary of the species occurring in New Guinea.

- A. Calyx 5-ribbed; upper lobes over half the length of lower lobes of corolla.
- B. Corolla white, 12-15 mm. long, externally evidently pubescent, the throat distinctly wider than the tube and only slightly decurved; posterior calyx-lobe much shorter than the others.1. *S. alba*.
- BB. Corolla brightly colored, smaller.
- C. Corolla orange-yellow; stems relatively tall and weak, much-branched.2. *S. Schlechteri*.
- CC. Corolla reddish purple, 7-8 mm. long, externally minutely pubescent, the throat ill-defined though slightly longer than the tube, rather strongly decurved; posterior calyx-lobe as long as the others.3. *S. parviflora*.
- AA. Calyx 10-15-ribbed; upper lobes less than half the length of lower lobes of corolla.
- B. Corolla yellow, unlined, the anterior lobes reaching 3 mm. long; calyx 5 mm. long; plant 1-3 dm. tall.4. *S. lutea*.
- BB. Corolla white, venose-lined, the anterior lobes reaching 13 mm. long; calyx 10 mm. long; plant taller.5. *S. Masuria*.

*1. *Striga alba* sp. nov.

Caulis 7-8 dm. altus, scabro-pilosus, ramosus; folia linearia, obtusa, scabro-pubescentia, majora 2-4 cm. longa; spicae elongatae, multiflorae; bracteae lineares, attenuatae, 5-6 mm. longae; bracteolae filiformes, 3.5-5 mm. longae; pedicelli brevissimi; calyx 6 mm. longus, tubo prominente 5-costato (costis scabro-pubescentibus), lobis subulatis scabris, supremo lobo caeteris brevior; corolla 13-15 mm. longa, alba, violaceo-lineata, tubo tenui, fauce tubulari-campanulato, extus pubescente, parum decurvo, labio superiore 2-3 mm. longo pubescente, labio inferiore 3.5-4.5 mm. longo glabrato; capsula 2.5 mm. longa, ovoidea; semina 0.5 mm. longa.

Stem 7-8 dm. tall, scabrous-pilose with short broad-based stiff spreading hairs, slightly branched distally. Leaves ascending, linear, obtuse, scabrous-pubescent, the largest 2-4 cm. long, 1-1.5 mm. wide. Spikes elongated, scabro-pubescent, that of the main stem of more than 20 opposite or sub-opposite pairs of flowers. Bracts linear, attenuate, mostly 5-6 mm. long, about $\frac{2}{3}$ the length of calyx, the lower long and exceeding calyx. Bracteoles filiform, 3.5-5 mm. long. Pedicels scarcely 0.5 mm. long. Calyx 6 mm.

¹³Already reported in Jour. Arnold Arb. 20: 83, 1939, as a variant of *Buchnera urticifolia*. These are the plants covered by contrast "AA" of the key.

long, its tube with 5 very prominent scabro-pubescent ridges that become distally the subulate scabro-pubescent calyx-lobes, four of which are equal, 2–2.5 mm. long, but the mid-posterior is more slender and short, 1.5 mm. long; intervening surface of the tube membranous, sparsely minutely pilose, cut more deeply on posterior side, so that the shortest calyx-lobe is free proximad to the others. Corolla 13–15 mm. long, white, the throat and lobes finely violet-lined, the tube slender and about equaling calyx (5–6 mm. long), glabrous within calyx; throat tubular-campanulate, slightly enlarged on upper side, 4–5 mm. long, slightly decurved, externally pubescent, the hairs seemingly slightly gland-tipped; upper lip 2–3 mm. long, arched, its lobes united over half their length, free and laterally up-curved, externally slightly glandular-pubescent, internally pubescent with appressed glandless hairs; lower lip 3.5–4.5 mm. long, deflexed-spreading (its laterally spreading lobes distinct from near base of lip), externally slightly glandular-puberulent, internally glabrous. Capsule 2.5 mm. long, ovoid, glabrous, enclosed within calyx-tube. Seeds about 0.5 mm. long,¹⁴ irregularly tetrahedral, brown.

BRITISH NEW GUINEA: Gaima, east bank of Lower Fly River, *L. J. Brass 8256* (ANSP, TYPE, AA), Nov. 1936, in flower and fruit (common in thick grass, open savanna-forest, in lowland).

In 1939 (*Jour. Arnold Arb.* **20**: 83) I identified this plant as *Striga curviflora* (R. Br.) Benth., an opinion I wish now to reconsider. Robert Brown's brief description of *Buchnera curviflora* (*Prodr. Fl. Nov. Holl.* 438. 1810) should first be quoted: "*Buchnera curviflora*, scaberrima, foliis elongato-linearibus integerrimis patentibus, calycibus 5-striatis, labio superiore corollae retuso: inferiore 3-partito ter brevior." Our plant differs from this in its leaves being ascending rather than spreading, and in its upper lip being $\frac{2}{3}$ instead of $\frac{1}{3}$ the length of the lower lip of the corolla. In 1835 (in forming the combination *Striga curviflora* in *Compan. Bot. Mag.* **1**: 362) Bentham, who had seen only Brown's specimens for his account, called the leaves subspreading ("subpatentibus"), thus indicating that they were likely somewhat ascending, and added that the corolla-tube was pubescent, while he retained in full force the statement about the relatively small upper lip of the corolla. Years later, with the help of more collections, Bentham again treated the matter in his *Flora Australiensis* (**4**: 517) in 1869. There we learn that Brown's plant, the type of the species, was gathered on islands in the Gulf of Carpenteria in North Australia, and that the species is now known both in that province and in Queensland. Again we have the emphasis placed upon the shortness of the upper corolla-lip as a main criterion ("less than half as long as the lower"), while the length of the corolla is now given as "nearly or fully $\frac{3}{4}$ in.," a size too large for our plant. On Bentham's key of 1869 our species fits better the characterization of *S. multiflora*, which reads: "Corolla above $\frac{1}{2}$ in. long, the upper lip more than half as long as the lower," except that the corolla is exactly $\frac{1}{2}$ inch. But from *S. multiflora* Benth. of North Australia (as originally defined in *Compan. Bot. Mag.*

¹⁴Imperfect seeds, shaken from a capsule, are only 0.2–0.3 mm. long, but those lying in folder with specimen and presumably of this species have been described.

1: 363. 1835) our plant differs in not being much-branched, its leaves not spreading, its corolla not glabrous, and its habit not semi-decumbent. Finally, as to *S. curviflora* again, the scarcely decurved corolla of our plant must differ from that which suggested this name to Brown. On all these counts I think that our plant from New Guinea is different from either of these Australian species. Likely it differs in other characters as well, for Brown's description is meagre and Bentham's far from complete.

2. *Striga Schlechteri* sp. nov.

Caulis ramosissimus, debilis; folia longa; calyx 5-costatus; corolla lutea.

Stems much-branched, weak and rather tall (relative to *S. lutea*), the leaves longer, the calyx 5-ribbed, the corolla bright orange-yellow (but drying dark blue-gray), and both corolla and capsule smaller.

NORTHEASTERN NEW GUINEA: Constantinhafen, R. Schlechter 14246 (TYPE, presumably in the Berlin Botanical Garden), March 1902, in flower and fruit.

Other collections cited by Schlechter show this as occurring elsewhere in Northeastern New Guinea.

This brief characterization is all that is given by Schlechter (in Bot. Jahrb. 59: 114. 1924), but it seems sufficient to mark this as another new species. Certainly it can hardly be *Striga multiflora* Benth., above-mentioned, to which Schlechter assigned the plant, since Bentham's account of this in his Flora Australiensis (4: 517. 1869) gave the corolla as over $\frac{1}{2}$ inch long, a size much above that of *S. lutea*. On the other hand it is just possible that Schlechter's plant was *S. parviflora*, but his identification of it as *S. multiflora* and the different color assigned to the flowers lead me to suppose that it is something else. *S. multiflora* was originally described as having a glabrous corolla, a detail so modified in the Flora Australiensis as to lead to the suspicion that several things were included in the latter account.

3. *Striga parviflora* (R. Brown) Benth. in Compan. Bot. Mag. 1: 362. 1835.

Based upon *Buchnera parviflora* R. Brown, Prodr. Fl. Nov. Holl. 1: 438. 1810, of tropical Australia, the type being stated by Bentham, Fl. Austral. 4: 517. 1869, to have come from Keppel Bay, Queensland.

As previously reported (in Jour. Arnold Arb. 20: 84. 1939), this was collected in British New Guinea at Port Moresby (*Brass* 8780), and now we may add several collections from near Kajabit Mission in the Morobe District, Northeastern New Guinea (*Mary S. Clemens* 10676, 10745, 41170).

4. *Striga lutea* Loureiro, Fl. Cochinch. 22. 1790.

Type actually from Canton, China. Merrill (in Trans. Amer. Philos. Soc. II. 24(2): 353. 1935) puts this in the synonymy of *Striga asiatica* (L.) Kuntze, but Linnaeus' *Buchnera asiatica* was a composite of whatever *Strigae* he knew, although his allusion to the corolla-limb being purple will likely prove distinctive. With which component to associate this earliest name must await more thorough revision.

To collections cited by Schlechter (l. c. 115), all from Northeastern

New Guinea, may be added a recent one from the Kajabit Mission in the Morobe District (*Mary S. Clemens* 40771).

5. *Striga Masuria* (Buch. Ham.) Benth. in Compan. Bot. Mag. 1: 364. 1835.

In Wallich's Numerical List of Plants in the Museum of the East India Company, this species appears as numbers 3876 *Buchnera Wallichii* Benth. and 3877 *B. Masuria* Ham., under date of 1830. Both names were *nomina subnuda* (localities only being given), but the latter was validated by publication with description by Bentham in his Scrophularineae Indicae (p. 41) in 1835. Schlechter in 1924 (l. c. 115) seems to have been the first to validate the former, but his *Striga Wallichii* (Benth.) Schlechter does so only by including Bentham's account of the other as a synonym. The correct name for the species therefore remains *Masuria*, the name generally used since 1835.

A widespread oriental species that extends eastward to New Guinea, where it was reported by Schlechter from the northeastern part and has recently been gathered slightly farther south at the Kajabit Mission, Morobe, Northeastern New Guinea, by *Mary S. Clemens* (10547a, 40658, 40772).

16. *Euphrasia* Linnaeus

This proves to be one of the characteristic genera of alpine heights throughout New Guinea. Like *Hebe* in the same situations, the kinship of the Papuan species is definitely with the flora of New Zealand. Also like *Hebe*, the genus will prove to be a large one in New Guinea, with many species locally endemic to various mountain areas.

The clarity of the taxonomy of *Euphrasia* in New Guinea has been a welcome surprise to one who has puzzled over the difficult task of distinguishing its species in the North Temperate Zone. The boreal species, all of which are annual, are closely similar in corollas, stamens, capsules, seeds, calyces, and leaves, so that one must appeal to secondary features of leaf-dentation, indumentum, and size to distinguish the many local entities. But in New Guinea the characters are as consequential and well-marked as in any other genus of this family. The species are perennial, the habit either erect or repent, the corolla with short or long tube, the calyx-lobes rounded or acuminate, and the anthers distinct or coherent, uniformly or unequally awned. Those as yet known from New Guinea may be distinguished as follows:

- A. Corolla externally glabrous, 10–11 mm. long, the lips as long as or longer than the tube; anthers glabrous, exserted; leaf-blades 3–5-lobulate; stem to 2 dm. tall. 1. *E. papuana*.
- AA. Corolla externally pubescent; anthers included, at least the orifices ciliate; leaf-blades 3-lobed, or the lower or all entire (all only in *E. culminicola*).
- B. Leaf-blades longer than wide, the lateral lobes less than $\frac{1}{3}$ the length of the wide median lobe; lower lip deflexed, usually exceeding the upper lip of the corolla; stem ascending or erect.
- C. Stems shrubby, 1–3 dm. tall; calyx-lobes obtuse; corolla 12–14 mm. long, white to yellow, externally sparsely puberulent, the lower (8 mm.) slightly longer than the upper (6–7 mm.) lip. 2. *E. Lamii*.
- CC. Stems suffruticose, less than 1 dm. tall; corolla violet to purple, evidently hairy externally.

- D. Anthers cohering, one awn of anthers of shorter stamens much longer and thicker than the other anther-awns; corolla 12–15 mm. long, the campanulately widened throat and lips as long as or longer than the narrow tube; leaves glabrous.
- E. Lower distinctly exceeding upper lip of corolla, its length about that of the straight corolla-tube and -throat.
- F. Calyx-lobes obtuse or obtusish.
- G. Leaf-blades with a pair of short tooth-like obtuse lobes; corolla purple.....3. *E. cucullata*.
- GG. Leaf-blades entire, spatulate or obovate....4. *E. culminicola*.
- FF. Calyx-lobes acuminate; corolla white or very pale pink.....5. *E. mirabilis*.
- EE. Lower scarcely exceeding upper lip of corolla, its length about half of that of the decurved corolla-tube and -throat; calyx-lobes acuminate.....6. *E. curviflora*.
- DD. Anthers distinct, the awns all equal in length, short; corolla 9–11 mm. long, the slender throat gradually or not widening from the tube, which together are at least twice as long as the lobes.
- E. Tube of corolla gradually widening to apex, its orifice not constricted; plant much-branched at base.
- F. Calyx-lobes acuminate; corolla pale violet, the galea straight continuously with the tube; capsule little shorter than calyx; leaves 5–6 mm. long, glabrous.....7. *E. rectiflora*.
- FF. Calyx-lobes rounded at apex; corolla lavender to dark violet, the galea shorter and curved continuously with the tube; capsule shorter than calyx (not surpassing the mid-portion of its lobes); leaves 3–4 mm. long, puberulent.....8. *E. spatulifolia*.
- EE. Tube of corolla constricted at mouth; leaves 3.5 mm. long, glabrous; stems simple or sparsely branched.....9. *E. scutellarioides*.
- BB. Leaf-blades as wide as long, the lateral lobes $\frac{1}{4}$ to $\frac{1}{2}$ the length of the wide median lobe; lower lip deflexed-spreading, not or scarcely exceeding the upper lip of the pale corolla; anthers distinct, one awn of anthers of shorter pair slightly longer than the other anther-awns; stem repent.
- C. Corolla 8–10 mm. long, slightly and mostly sparsely pilose externally; orifice of anther-cells ciliolate (the hairs less than $\frac{1}{4}$ the width of the cell); calyx pilose to glabrate, the lobes obtuse with margins slightly revolute, not callose; leaves 2–4 mm. long, glabrate, the margin like that of the calyx-lobes; stems extensively repent, bifariously pubescent with recurved hairs.....10. *E. humifusa*.
- CC. Corolla 4–5 mm. long, hirsute-pubescent externally; orifice of anther-cells ciliate (the hairs over half the width of the cell); calyx more densely white-pubescent, the lobes rounded with margin strongly revolute and callose; leaves 1–3 mm. long, pubescent, ultimately glabrous, the margin like that of the calyx-lobes; stems more shortly spreading.....11. *E. callosa*.

1. *Euphrasia papuana* Schlechter in Bot. Jahrb. **59**: 116. 1924.

Collected by Sir William MacGregor in 1889 on Mt. Victoria in British New Guinea.

2. *Euphrasia Lamii* Diels in Nova Guinea Bot. **14**: 538. 1928.

Collected by H. J. Lam in 1920 at Doorman Peak, Netherlands New Guinea; two specimens cited but neither designated as type. *Lam 1587*, very abundant on flat sterile moorland, 3250 meters altitude, is also shown in his photograph in Die Vegetationsbilder **15**: tab. 33. 1924, and evidently reaches the proportions given in the original description of 1928. Accordingly, I take it as the type. The published field-note states that the

corolla was white or bright yellow, sometimes with lilac spots on the lips, and was yellow on the throat. In contrast, *Lam 1644*, gathered among stones on open alpine slopes at 3520 meters altitude, was noted in the field as with corolla white, occasionally bright yellow, yellow at the throat, and the tube with violet stripes to the margin of the upper lip; I suspect from the allusion to striping as well as the different environment that no. 1644 is a different species and is probably the plant that I am now describing as *Euphrasia cucullata*, although unfortunately Mr. Brass has not told us the color-pattern of the latter. If so, the occasional bright yellow-flowered individuals may well be interspersed specimens of *E. Lamii*, such as might take slightly wetter spots. From Lam's map in *Die Vegetationsbilder*, Doorman Peak is less than a degree northwest of Wilhelmina Peak.¹⁵

*3. *Euphrasia cucullata* sp. nov.

Suffruticosa, ramosissima, diffusa, 5–10 cm. alta; caulis retrorse pubescens; folia obovato-spathulata, 5–6 mm. longa, glabra, margine apicem versus valde revoluta (cucullata), utrinque pari loborum triangulari-rotundatorum onusta, basi cuneata; flores pauci, axillares; calyx minute pilosus, 6–7 mm. longus, lobis ovatis rotundatis 2 mm. longis; corolla purpurea, extus hirsuto-pubescent, tubo 7–8 mm. longo angusto, labio superiore 5 mm. longo. inferiore 7–9 mm. longo lobis retusis aucto; antherarum cohaerentium thecae aristas inaequales ferentes, orificiis ciliatae; stylus pubescens; capsula 7 mm. longa, glabra; semina 1.5 mm. longa.

Suffruticose, much-branched below, the stems less than 1 dm. tall, pubescent with recurved hairs, diffusely ascending or decumbent. Leaves glabrous, obovate-spatulate, cuneate to base, about midway of length with a pair of triangularly rounded short lobes,¹⁶ the median distal portion obovate (much wrinkled in drying), rounded, the margin so strongly revolute as to appear cucullate; larger leaves 5–6 mm. long, 2–3 mm. wide. Inflorescence of a few pairs of axillary flowers, these not closely successive. Pedicels 2 mm. long, pubescent. Calyx 6–7 mm. long, minutely pilose, the lobes 2 mm. long, ovate, rounded but with margin so recurved as at times to appear acutish. Corolla "purple," externally hirsute-pubescent, but glabrous beneath throat and on lobes distally, internally finely pubescent below posterior sinus,¹⁷ elsewhere glabrous (except perhaps at base of tube), the tube 7–8 mm. long, narrow, slightly exceeding the calyx; upper lip 5 mm. long, slightly arched and hooded, the lobes free slightly (0.5 mm.) at apex; lower lip 7–9 mm. long, deflexed-spreading, the mid-anterior obovate, slightly longer than the semirectangular antero-lateral lobes, all retuse. Filaments glabrous (except probably at base); anthers all coherent, the

¹⁵If the anthers of *Euphrasia Lamii* had been described in detail, probably it would have been possible to associate it with some of the following species. At present it is impossible to identify its variety *Versteegii* Diels (in *Nova Guinea Bot.* 14: 539. 1928), collected by Versteeg (no. 2473) in 1913 on the Orange Mountains ("Oranje-Gebirge") in Netherlands New Guinea.

¹⁶These are shorter and less divaricate than in *Euphrasia mirabilis*, the lobes of which are also placed about the middle of the leaf's length (not so distally as is implied in my original description of that plant). The leaf-blade is distally more strongly cucullate in *E. cucullata* than in *E. mirabilis*.

¹⁷Such fine pubescence beneath sinus near apex of upper lip is developed also in *E. mirabilis*.

cells ciliolate at margins of orifices, all awned (one awn of each posterior anther 0.5 mm. long, the other awns 0.2 mm. long,¹⁸ the long awn stouter and projecting farther down into the orifice of the corolla). Style distally pubescent. Capsule 7 mm. long, 5 mm. wide, widely obovoid and somewhat flattened, retuse, glabrous. Seeds at least 1.5 mm. long, brownish, with longitudinal thin white ridges.

NETHERLANDS NEW GUINEA: Mt. Wilhelmina, 2 km. east of summit, alt. 3800 m., *L. J. Brass & E. Myer-Drees 10118* (ANSP, TYPE, AA), Sept. 1938, in flower (alpine grassland, plentiful in sterile shallow soil of sandstone crests); 3 miles east of summit, Mt. Wilhelmina, alt. 3650 m., *Brass 9412* (AA, ANSP) (scattered over black boggy slopes).

4. *Euphrasia culminicola* Wernham in Trans. Linn. Soc. II. Bot. **9**: 121. 1916.

Collected by C. Boden Kloss in 1912-13 on Carstensz Peak, in Netherlands New Guinea.

5. *Euphrasia mirabilis* Pennell in Brittonia **2**: 188. 1936.

Collected by L. J. Brass, no. 4271, in 1933 on Mt. Albert Edward, in British New Guinea.

*6. *Euphrasia curviflora* sp. nov.

Caules laxi, 8 cm. et ultra longi, pilis patentibus hirsutuli; folia glabra, oblanceolata vel obovato-spathulata, 5 mm. longa, margine apicem versus revoluta, utrinque pari loborum lanceolato-oblongorum brevium onusta, basi anguste cuneata; flores pauci, axillares; calyx glabratus, 7.5 mm. longus, lobis ovatis acuminatis 3.5 mm. longis; corolla violaceo-purpurea, extus pubescens, tubo 5 mm. longo angusto, labio superiore 4 mm. longo, inferiore vix longiore lobis retusis aucto; antherarum cohaerentium thecae aristas inaequales ferentes, orificiis ciliolatae; capsula 6 mm. longa, glabra; semina non visa.

Stems lax, at least 8 cm. long, probably ascending, finely hirsute with spreading hairs. Leaves glabrous, oblanceolate to obovate-spatulate, narrowly cuneate to base, about midway of length with a pair of lance-oblong short lobes, the median distal portion rounded-ovate, the margin somewhat revolute and slightly cucullate, those seen 5 mm. long, 2-2.5 mm. wide. Inflorescence of a few pairs of axillary flowers. Pedicels scarcely 1 mm. long, apparently glabrate. Calyx 7.5 mm. long, minutely pubescent below sinuses, becoming glabrous throughout, the lobes 3.5 mm. long, ovate, acuminate, slightly revolute. Corolla externally pubescent, hirsutely so on tube and minutely villose on galea, the lobes distally glabrate, internally pubescent below posterior sinus, the tube 5 mm. long, narrow, about equaling the calyx, distally campanulate, widening to a throat 4 mm. long; upper lip 4 mm. long, arched, the lobes free slightly at apex and laterally recurved 0.5 mm.; lower lip scarcely longer, deflexed-spreading, the mid-anterior slightly the widest, all retuse. Filaments glabrous (at least distally); anthers all coherent, the cells ciliolate at margins of orifice, all awned (one awn of each posterior anther 0.3 mm. long, the others 0.1 mm. long, the long awn stouter and projecting farther down into the orifice of the corolla). Capsule 6 mm. long, 4 mm. wide, obovate-rounded to apex, flattened, glabrous. Seeds not seen.

NORTHEASTERN NEW GUINEA: Morobe District, Rawlinson Range, alt. over 3600 m., *Mary S. Clemens s. n.* (ANSP, TYPE), July 1941, in flower (open wet hills and dale).

¹⁸About twice as long as the corresponding awns of *E. mirabilis*.

Of this I have seen only a few pieces, including a flower, a nearly ripe capsule, and another capsule long past dehiscence, all culled from the only collection of *Euphrasia callosa*, to be described below. As to color, the common label states: "mixture, purple & white, tube yellow of big fl.," whence we know that this, the big flower, had a yellow corolla-tube, a color still evident on the anterior side of the throat. The edge of the lower corolla-lobes seems still a dark violet, whence I infer that the main part of the corolla was violet-purple.

*7. *Euphrasia rectiflora* sp. nov.

Suffruticosa, basi ramosa, erecta vel diffusa, 1–7 cm. alta; caulis retrorse pubescens vel glabrata; folia glabra, oblanceolato-spathulata, 5–6 mm. longa, margine apicem versus revoluta, utrinque pari loborum triangulari-oblongorum rotundatorum onusta, basi cuneata; flores pauci, axillares; calyx glaber, 7 mm. longus, lobis lanceolatis acuminatis 3 mm. longis; corolla violacea, extus minute pubescens, tubo 10 mm. longo angusto elongato, labiis 3 mm. longis, inferiore lobis rotundato-truncatis aucto; antherarum distinctarum thecae aristas aequales ferentes, orificiis cilio-latae; stylus minute pubescens; capsula 5–6 mm. longa, glabra; semina non visa.

Suffruticose, less than 7 cm. tall, often minute, much-branched at base, the stems erect or diffuse-decumbent, finely pubescent with recurved hairs to glabrate. Leaves glabrous, oblanceolate-spatulate, the upper nearly obovate, cuneate to base, about midway of length with a pair of triangular-oblong rounded lobes, the mid-blade distally broadly rounded, its margin revolute (but hardly cucullate) and becoming indurated, the larger leaves 5–6 mm. long, 2–3 mm. wide. Inflorescence of a few (1 or 2) pairs of axillary flowers, borne contiguously at the summit of the stems. Pedicels less than 1 mm. long, glabrous. Calyx becoming 7 mm. long, glabrous, the lobes 3 mm. long, lanceolate, acuminate, the margin strongly revolute. Corolla "pale violet with yellow spot inside,"¹⁹ apparently lined, externally finely pubescent, the tube anteriorly and the lower lobes glabrous, internally minutely pubescent below posterior sinus, the tube 10 mm. long, narrow, gradually widening distally, over twice the length of the calyx; upper lip 3 mm. long, narrowly arched, scarcely or not hooded, the lobes free slightly at apex (0.5 mm.), tending to spread laterally; lower lip 3 mm. long, widely deflexed-spreading, the lobes 2 mm. long, rounded-truncate, slightly widening distally. Filaments glabrous (except perhaps at base); anthers distinct, the cells ciliolate at margins of orifice, all equally awned (awns slender, 0.3 mm. long). Style distally finely pubescent. Capsule 5–6 mm. long, 4 mm. wide, obovate, flattened. Seeds not seen.

NETHERLANDS NEW GUINEA: Lake Habbema, north of Mt. Wilhelmina, alt. 3225 m., *L. J. Brass* 9192 (AA, TYPE, ANSP), Aug. 1938, in flower and fruit (among dwarf grasses of exposed boggy slopes); 7 km. northeast of Mt. Wilhelmina, alt. 3560 m., *Brass & Myer-Drees* 9794 (AA, ANSP) (on very wet peat in grassy valley).

*8. *Euphrasia spatulifolia* sp. nov.

Suffruticosa, caespitosa, diffusa, 1–7 cm. alta; caulis pilis patentibus pubescens; folia minute pubescentia, oblanceolato-spathulata, 3–4 mm. longa, margine apicem versus valde revoluta (cucullata), utrinque pari

¹⁹From label of no. 9794; for no. 9192 stated as "pale purple-pink."

loborum oblongorum onusta, basi cuneata; flores pauci, axillares; calyx hispidulus, 7 mm. longus, lobis oblongis rotundatis 3 mm. longis; corolla violacea, extus pubescens, tubo 9 mm. longo tenui elongato, labio superiore 2 mm. longo, inferiore 4 mm. longo lobis rotundato-truncatis aucto; antherarum distinctarum thecae aristas aequales ferentes, orificiis ciliatae; stylus minute pubescens; capsula 4–5 mm. longa; semina non visa.

Suffruticose, forming clumps up to 1 dm. in diameter. Plant less than 7 cm. tall, branched throughout, the stems diffuse from base and ascending, pubescent with spreading slightly recurved hairs. Leaves minutely pubescent, oblanceolate-spatulate, cuneate to base, about midway of length with a pair of oblong rounded or obtuse lobes, the mid-blade distally broadly rounded, its margin strongly revolute and somewhat hooded, the larger leaves 3–4 mm. long, 1.5–2 mm. wide. Inflorescence of a few (1 or 2) pairs of axillary flowers. Pedicels 1 mm. long. Calyx becoming 7 mm. long, minutely pilose with stiff hairs, the lobes 3 mm. long, oblong, truncately rounded, the margin narrowly revolute. Corolla "lavender" (no. 10044) or "dark violet" (no. 9731), with the "lowest petal orange at base," externally grayish-pubescent, the throat anteriorly and the lobes distally glabrous, internally minutely pubescent below posterior sinus, the tube 9 mm. long, narrow, proximally very slender, distally widening to form throat and somewhat decurved, over twice the length of the calyx; upper lip 2 mm. long, arched and decurved 1 mm., then the lobes widely spreading, rounded; lower lip 4 mm. long, deflexed-spreading, the lobes 2–2.5 mm. long, rounded-truncate, slightly widening distally. Filaments glabrous (at least distally); anthers distinct, the cells ciliate at margins of orifice, all equally awned (awns slender, 0.2 mm. long). Style distally finely pubescent. Capsule 4–5 mm. long, 2–3 mm. wide, obovate, flattened. Seeds not seen.

NETHERLANDS NEW GUINEA: Northern slopes of Mt. Wilhelmina, alt. 3950 m., L. J. Brass & E. Myer-Drees 10044 (AA, TYPE, ANSP), Sept. 1938, in flower and old fruit (shallow soil of old grassy scree); 11 km. northeast of summit of Mt. Wilhelmina, alt. 3400 m., Brass & Myer-Drees 9731 (AA, ANSP) (on rather wet sandy slope).

9. *Euphrasia scutellarioides* Wernham in Trans. Linn. Soc. II. Bot. 9: 122. 1916.

Collected by C. Boden Kloss in 1912–13 on Carstensz Peak, Netherlands New Guinea.

*10. *Euphrasia humifusa* sp. nov.

Herba perennis, effusa, repens; caulis 1 dm. longus, bifariam retrorse pubescens; folia glabra vel proxime pilosa, late ovata, 2–3 mm. longa, margine apicem versus parum revoluta, utrinque pari loborum oblongorum obtusorum onusta, basi anguste cuneata; flores pauci, irregulariter axillares; calyx hispidulus vel glabratus, 3–4 mm. longus, lobis ovatis vel ovato-oblongis 1.5 mm. longis; corolla rubescens, extus villosulo-pubescent, tubo 5 mm. longo angusto recto; labio superiore 2.5 mm. longo, inferiore 3 mm. longo lobis retusis aucto; antherarum distinctarum thecae aristas subaequales ferentes, orificiis ciliolatae; stylus glabratus; capsula 4 mm. longa, glabra; semina 1 mm. longa.

Perennial, widely effuse. Stems up to 1 dm. long, wholly prostrate, partially repent, much-branched, bifariously pubescent with recurved-appressed hairs. Leaves glabrous or pilose proximally above on midrib or with a few hairs at tip of blade or lobes, widely ovate in inclusive outline,

narrowly cuneate to a semi-petiolate or fully petiolate base, about midway of length with a pair of divergent oblong obtuse lobes, the mid-blade distally oval or rounded-ovate, its margin relatively slightly revolute; larger leaf-blades 2–3 mm. long and wide, the petioles sometimes reaching 1 mm. long. Calyx 3–4 mm. long, pilose with stiff hairs to usually glabrate, the lobes 1.5 mm. long, ovate or ovate-oblong, obtuse, so revolute as at times to appear acute. Corolla externally pinkish, internally white, the lips (or perhaps only lower lip) pink,²⁰ externally finely pubescent (usually villosely so), the throat anteriorly and the lobes distally glabrous, internally minutely pubescent below posterior sinus, the tube 5 mm. long, narrow, straight, nearly twice length of calyx, distally abruptly widening to a campanulate throat 2 mm. long; upper lip 2.5 mm. long, straight or slightly decurved, arched, the lobes free only near apex (0.2–0.3 mm. long), upcurving; lower lip 3 mm. long, deflexed-spreading, the lobes 2–2.3 mm. long, oblong, retuse. Filaments glabrous (at least distally); anthers distinct, the cells ciliolate on margins of orifice, the awns slightly unequal (awns slender, 0.1 mm. long, except one of the shorter pair of anthers which is about 0.2 mm. long). Style distally nearly glabrous (obscurely sparsely puberulent). Capsule 4 mm. long, 3 mm. wide, flattened, obovate-rounded, emarginate, the valves in dehiscence strongly recurved-spreading. Seeds 1 mm. long, oval with distally flattened end, blackish, with white longitudinal wing-like ridges.

NETHERLANDS NEW GUINEA: 4 km. northeast of summit of Mt. Wilhelmina, alt. 3650 m., *L. J. Brass & E. Myer-Drees 9971* (ANSP, TYPE, AA), Sept. 1938, in flower and fruit (in shade of tussock grasses); 2 km. east of summit of Mt. Wilhelmina, *Brass & Myer-Drees 10187* (AA, ANSP) (in alpine grassland).

*11. *Euphrasia callosa* sp. nov.

Herba perennis, effusa, prostrata; caulis 5 cm. longus, ramosus, hirsuto-pubescent; folia glabra glabratave, late ovata, 1–3 mm. longa, margine callosa apicem versus valde revoluta (cucullata), utrinque pari loborum oblongorum ovatorumve onusta, basi cuneata; flores pauci, irregulariter axillares; calyx hirsuto-pubescent, 3–4 mm. longus, lobis oblongis ovatisve 1 mm. longis; corolla alba, extus pubescent, tubo 2.5–4 mm. longo recto, labiis 1.5–2.5 mm. longis, inferiore lobis truncatis aucto; antherarum distinctarum thecae aristas subaequales ferentes, orificiis ciliatae; stylus minute pubescent; capsula 3 mm. longa, glabra; semina 0.7 mm. longa.

Perennial, widely effuse. Stems up to 5 cm. long, wholly prostrate, hirsute-pubescent on all sides with spreading hairs. Leaves glabrous, or slightly pubescent beneath laterally, widely ovate in inclusive outline, cuneate to a semipetiolate base, about midway of length with a pair of divergent oblong or ovate rounded lobes, the mid-blade distally ovate-rounded, the margin strongly revolute, even somewhat hooded, that of the lobes also revolute, all revolute margins and sometimes most of blade strongly callose; larger leaves 1–3 mm. long and wide. Inflorescence of several axillary flowers, occurring irregularly at various nodes. Pedicels 1–2 mm. long, hirsute-pubescent. Calyx 3–4 mm. long, hirsute-pubescent on ribs, the lobes 1–1.2 mm. long, oblong to ovate, distally acutish to rounded, with revolute strongly callose margin. Corolla probably white

²⁰Field-note to label for no. 9971: "fls. white within, the outside tinged with pink"; for no. 10187: "fls. very pale pink, lip darker."

or whitish,²¹ externally pubescent, the throat anteriorly and the lobes distally glabrous, internally minutely pubescent below posterior sinus, the tube (and throat) 2.5–4 mm. long, straight, little longer than calyx; upper lip 1.5–2.5 mm. long, straight or nearly so, the lobes slightly distinct and recurved near apex; lower lip about as long, deflexed-spreading, the lobes 1–1.5 mm. long, truncate or shallowly retuse. Filaments glabrous (at least distally); anthers distinct, the cells ciliate on margins of orifice, the awns slightly unequal (as in *E. humifusa*). Style distally finely pubescent. Capsule 3 mm. long and wide, flattened, rounded, glabrous. Seeds 0.7–0.8 mm. long, grayish, with longitudinal white ridges.

NORTHEASTERN NEW GUINEA: Morobe District, Ulap Trail, *Mary S. Clemens 41137* (ANSP, TYPE, AA), Apr. 6, 1940, in flower and fruit.

Presumably this locality is in the Rawlinson Range, from which Mrs. Clemens has sent to the Academy another collection made in July 1941, on "open wet hills and dale" at over 3600 meters altitude; it was this collection from which the few pieces of *Euphrasia curviflora* have been extracted. Still another collection, her no. 6047, gathered March 29, 1937, and credited only to the Morobe District at the surprisingly low altitude of 2400 to 2700 meters ("8–9000 ft.") is at the Arnold Arboretum.

EXPLANATION OF PLATES

All plates are photographs of herbarium specimens and are reproduced slightly over $\frac{1}{4}$ actual size.

PLATE I

A. *Lindernia papuana*; type. B. *Torenia crenata*; type.

PLATE II

A. *Hebe rubra*; isotype. B. *Hebe thymelaeoides*; isotype.

PLATE III

A. *Hebe albiflora*; type. B. *Hebe polyphylla*; type.

PLATE IV

A. *Hebe ciliata*; type. B. *Hebe rigida*; type.

PLATE V

A. *Hebe Brassii*; isotype. B. *Hebe tenuis*; type.

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²¹ Type collection labeled "fls. white with purple," probably meaning white with purple lines. As to other collection, intermixed with *Euphrasia curviflora*, I take the present species to be the pale-flowered component; see discussion under that species.



A. LINDERNIA PAPUANA

B. TORENIA CRENATA



Hebe thymelaeoides Pennell
(*Quercus* in herb. LSP)
Brass 4297



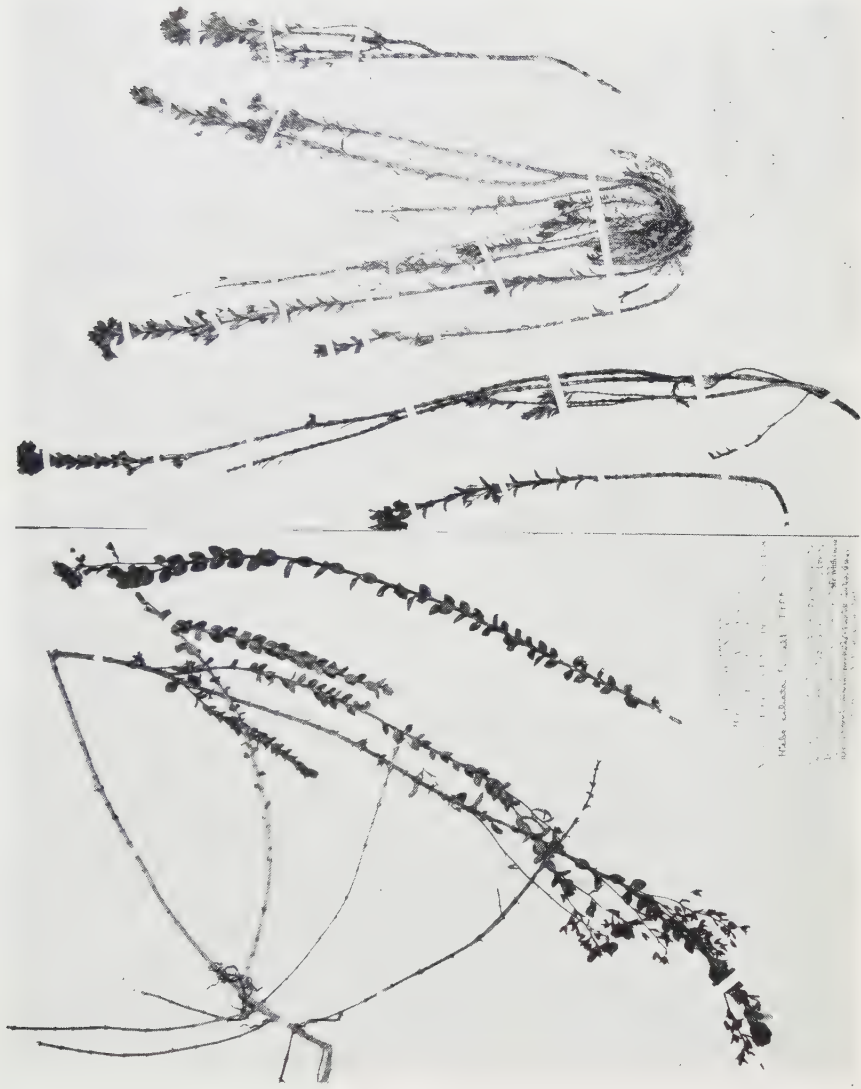
B. HEBE THYMLAEOIDES



A. HEBE RUBRA

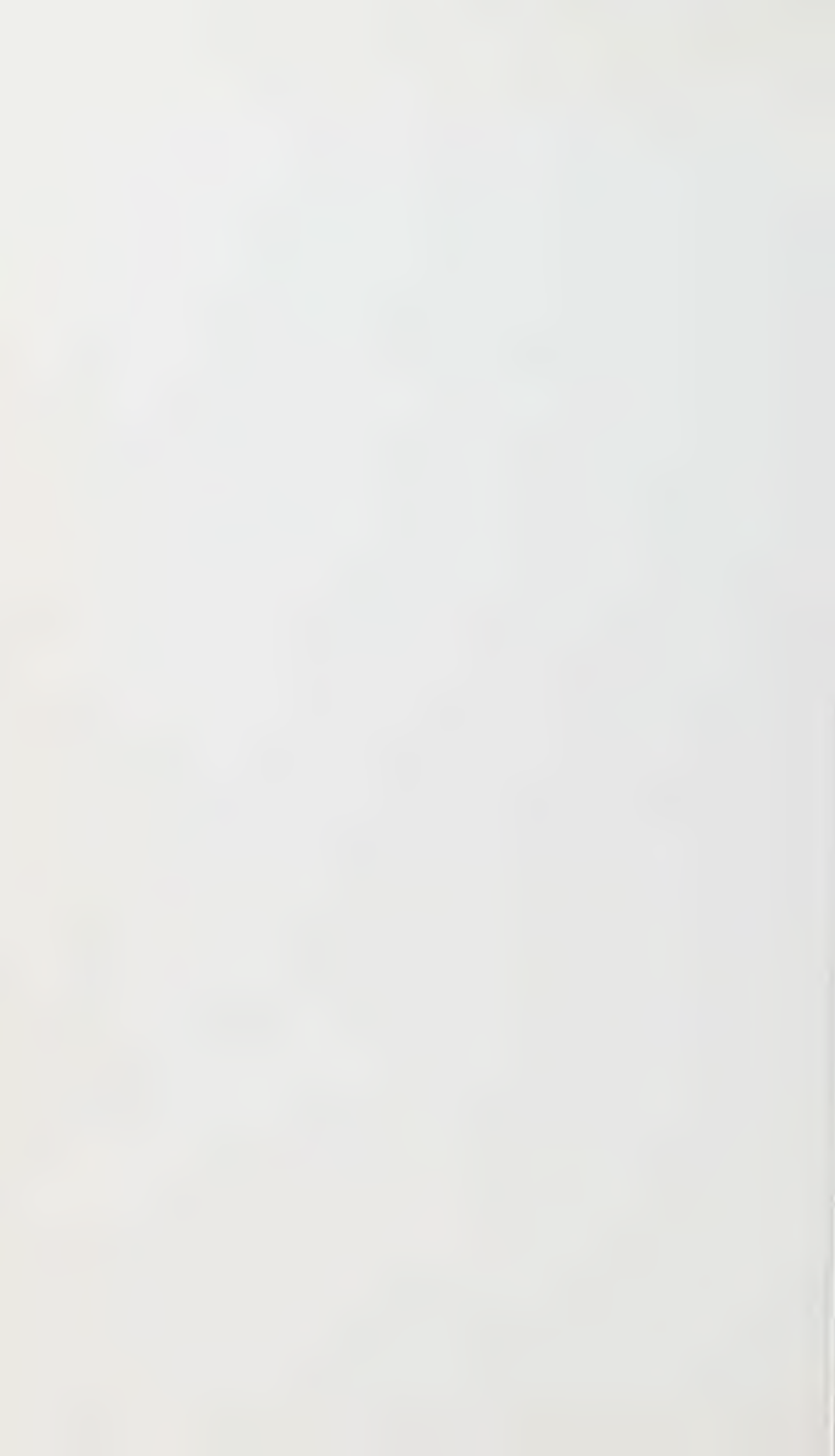


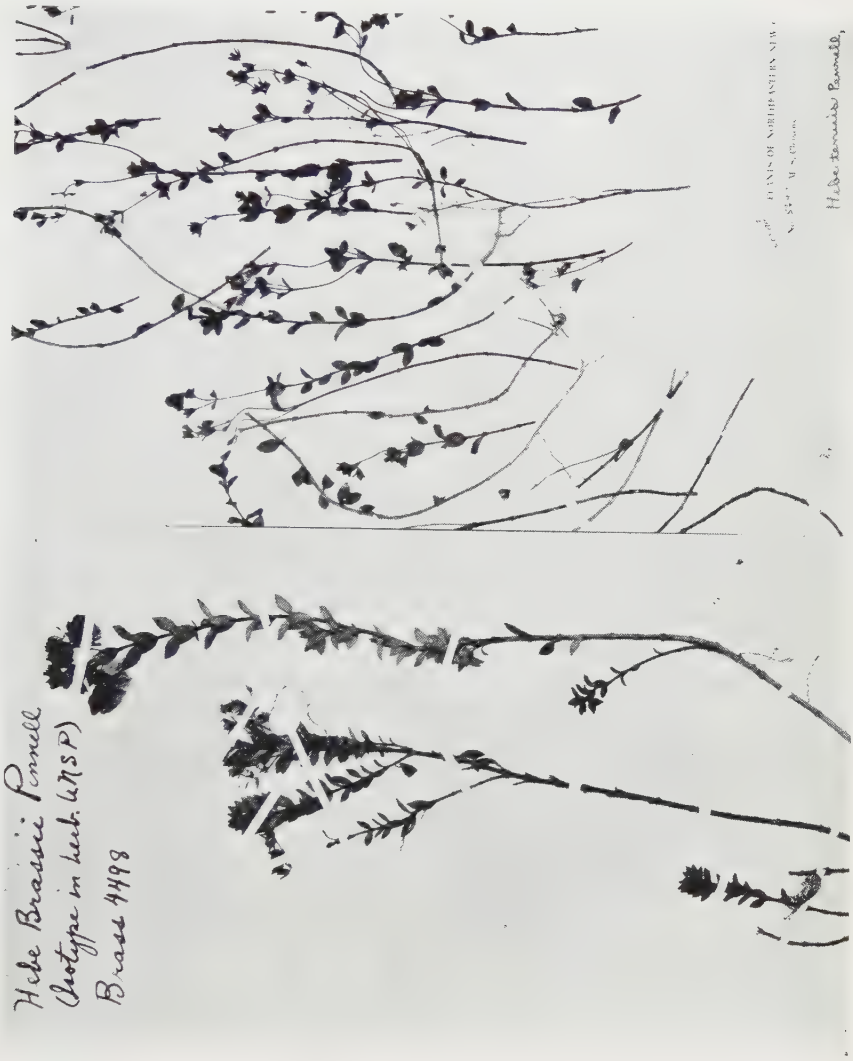




B. *HEBE FICIDA*

A. *HEBE CILIATA*





A. HEBE BRASSII

B. HEBE TENUIS



A STUDY OF CYTOLOGY AND SPECIATION IN THE GENUS *POPULUS* L.

E. CHALMERS SMITH¹

With four plates

INTRODUCTION

A STUDY of the extent of interspecific hybridization within a genus has both practical and theoretical importance. It is of value in showing to what degree hybridization may be utilized within a genus to establish improved types and, at the same time, it is indicative of the relationships of the species themselves. In order that the study of the extent of hybridization within the genus shall prove of maximum value, data on behavior of the F_1 and F_2 generations under controlled conditions should be available. Due to the time factor involved, such data are not available in most cases when dealing with forest trees.

The study of genetic behavior of interspecific hybrids is of greatest value when coupled with a comparative study of the cytology of those hybrids. Studies of this sort have yielded many pertinent facts, particularly as critical evidence for the establishment of probable interspecific relationships. In addition it has led to a better understanding of the actual methods by which isolation and speciation have taken place. The basic assumption underlying this method of approach to the problem of interrelationships of species is that the pairing of the parental chromosomes is a criterion of chromosome homology. This criterion of chromosome homology, based on a study of pairing relationships at meiosis in F_1 species hybrids, is particularly valuable when supplemented with a study of chiasmata frequencies, chromosome configurations, and pollen sterility.

The study of chromosome numbers, microsporogenesis, and the development of the male gametophyte of species within the genus supplements this program of research, making it more valuable from both points of view. The study of chromosome behavior and pollen sterility of the pure species serves as a basis with which to compare the cytological behavior of the hybrids. The chromosome numbers will indicate the degree of polyploidy within the genus and indicate the probable success of any attempt to induce polyploidy.

The present investigation is a study of the cytology of the genus *Populus* L. in general, and as such it is subject to the limitations imposed by the unavailability of certain species and hybrids for study. With these limitations in mind it is a study in particular of chromosome numbers and chromosome behavior in pure species and inter-specific hybrids, especially as these data are related to speciation within the genus.

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MATERIALS AND METHODS

The materials used in this study were obtained from two sources: (1) the *Populus* collection of the Arnold Arboretum, and (2) the *Populus* plantations of the Northeastern Forest Experiment Station at Frye, Maine. Cytological material of species and natural hybrids were obtained from the former location and material of artificial hybrids from the latter.

Branches with flower buds attached were collected during the latter part of February and early March, placed in the greenhouse, and allowed to develop. Catkins were collected at appropriate times and fixed in 3:1 alcohol acetic and stored in the fixative at 2° C. until needed. Male catkins of *Populus* make exceptionally favorable material for cytological study, since one catkin contains many successive stages in the development of the pollen grain.

Aceto-carminic smear preparations were used entirely in the study of meiotic chromosomes. Pollen mother cells in prophase stages were difficult to stain, and those having the chromosomes advantageously placed for study were rare. When favorable cells were found, the chromosomes were drawn with the aid of a camera lucida. The length of the chromosomes was then measured by the use of waxed threads.

For root tip studies, cuttings from the desired species were rooted in water or sand, the root tips collected and fixed in Navaschin's solution, embedded in paraffin, sectioned at 10 μ and stained with crystal violet. A similar procedure of fixation, embedding, and sectioning was followed in the study of the development of the male gametophyte, except in this case the sections were stained with Haidenhain's iron-haematoxylin.

In the study of the development of the pollen tube, freshly shed pollen was sprinkled on slides which had received a thin coating of a sugar, agar, gelatin, and water mixture. The preparation of these slides has been described by Newcomer (1938). In this case a mixture of 2 gm. sugar, 0.5 gm. agar, and 0.5 gm. gelatin to 25 cc. of water was found to be satisfactory. After the pollen was planted, the slides were placed in a moist chamber until the pollen had germinated. It was then fixed with 3:1 alcohol acetic and stained with aceto-carminic.

CHROMOSOME NUMBER AND MORPHOLOGY

The first investigation of the chromosomes of *Populus* was made by Graf in 1921. He found the reduced chromosome number in *P. tremula* and *P. canadensis*, as determined from reduction divisions in the embryo sac mother cells, to be four. These counts have since proved to be erroneous. In 1924 Blackburn and Harrison, on the basis of chromosome number in seven species of *Populus* and seventeen species of *Salix*, established the fundamental reduced chromosome number in the Salicaceae as nineteen. In *Salix*, a polyploid series based on multiples of two, four and six was found. Since 1924 various workers have studied chromosome numbers in *Populus*. Table I summarizes the chromosome numbers which have been determined up to this time and lists the authority for each

TABLE 1.
PREVIOUSLY DETERMINED CHROMOSOME NUMBERS OF *POPULUS*
SPECIES, WITH AUTHORITY AND DATE.

Species	Diploid Number	Authority
*P. alba	38	Von Wettstein (1933)
*P. alba	57	Peto (1938), van Dillewijn (1940)
P. alba var. nivea aureo-intertexta	57	Peto (1938)
P. balsamifera ¹	38	Meurman (1925)
P. canescens	38	Peto (1938)
P. canescens	57	Peto (1938)
P. deltoides var. missouriensis	38	Van Dillewijn (1940)
*P. Eugenei ²	38	Blackburn (1926), Peto (1938)
P. gelrica	38	Van Dillewijn (1940)
*P. generosa	38	Blackburn (1926)
*P. grandidentata	38	Peto (1938)
P. lasiocarpa	38	Von Wettstein (1933)
*P. nigra	38	Blackburn and Harrison (1924), van Dillewijn (1940)
*P. nigra var. italica	38	Van Dillewijn (1940)
*P. robusta	38	Van Dillewijn (1940)
P. serotina ³	38	Blackburn (1926)
*P. serotina	38	Van Dillewijn (1940)
P. Sieboldii	38	Nakajima (1937)
*P. Simonii	38	Meurman (1925)
P. tremula	38	Blackburn and Harrison (1924)
P. tremula	38	Von Wettstein (1933), Muntzing (1936)
P. tremula	57	*Muntzing (1936), Tometorp (1937)
*P. tremuloides	38	Erlanson and Hermann (1927), Peto (1938)
*P. trichocarpa	38	Meurman (1927)

* Count confirmed in the present study.

¹ P. balsamifera L. = P. deltoides Marsh. var. missouriensis Henry.

² P. Eugenei probably = \times P. canadensis Moench, var. Eugenei (Simon-Louis) Schelle

³ P. serotina Hartig = \times P. canadensis Moench, var. serotina (Hartig) Rehd.

count. Table II shows the distribution of chromosome numbers among the sections of the genus. Those determined by the writer are indicated in this table. In all, some forty-five species, varieties, and natural hybrids have been investigated.

An examination of these numbers reveals that no polyploid series similar to that found in *Salix* exists in *Populus*. All species exist in the diploid form with the diploid number of chromosomes equal to thirty-eight. However, in the section *Leuce*, three species are found which possess triploid forms also, with the unreduced chromosome number of fifty-seven.

It should be pointed out that, in most cases, the chromosome numbers for any particular species have been determined from the examination of but one or, at the most, a few specimens of the species. It is possible that the examination of a species throughout its entire range might reveal

TABLE 2.

A LIST OF CHROMOSOME NUMBERS OF *POPULUS* SPECIES AND VARIETIES, SHOWING THE DISTRIBUTION OF THESE NUMBERS AMONG THE SECTIONS OF THE GENUS.

Section	Species	Chromosome Number, 2N
Leuce	<i>P. alba</i> L.	38, 57
	<i>P. alba</i> var. <i>nivea</i> aureo-intertexta	57
	* <i>P. adenopoda</i> Maxim.	38
	<i>P. canescens</i> (Ait.) Sm.	38, 57
	<i>P. grandidentata</i> Michx.	38
	<i>P. Sieboldii</i> Miq.	38
	<i>P. tremula</i> L.	38, 57
	<i>P. tremuloides</i> Michx.	38
	* <i>P. tomentosa</i> Carr.	38
Leucoides	<i>P. lasiocarpa</i> Oliv.	38
Tacamahaca	* <i>P. acuminata</i> Rydb.	38
	** <i>P. angustifolia</i> James	38
	** <i>P. candicans</i> Ait.	38
	* <i>P. cathayana</i> Rehd.	38
	× <i>P. generosa</i> Henry	38
	*× <i>P. Jackii</i> Sarg.	38
	* <i>P. koreana</i> Rehd.	38
	* <i>P. laurifolia</i> Ledeb.	38
	** <i>P. Maximowiczii</i> Henry	38
	<i>P. Simonii</i> Carr.	38
	** <i>P. Tacamahaca</i> Mill.	38
	* <i>P. Tacamahaca</i> var. <i>Michauxii</i> (Dode) Farwell	38
	<i>P. trichocarpa</i> Hook.	38
	** <i>P. trichocarpa</i> var. <i>hastata</i> Henry	38
	*× <i>P. Woobstii</i> (Reg.) Dode	38
Aegeiros	*× <i>P. Andrewsii</i> Sarg.	38
	** <i>P. angulata</i> Ait.	38
	× <i>P. barbantica</i> Houtz.	38
	*× <i>P. berolinensis</i> Dipp.	38
	*× <i>P. canadensis</i> Moench	38
	*× <i>P. canadensis</i> var. <i>erecta</i> (Selys-Longchamps) Rehd.	38
	× <i>P. canadensis</i> var. <i>Eugenei</i> (Simon-Louis) Schelle	38
	*× <i>P. canadensis</i> var. <i>marilandica</i> (Poir.) Rehd.	38
	*× <i>P. canadensis</i> var. <i>regenerata</i> (Schneid.) Rehd.	38
	× <i>P. canadensis</i> var. <i>serotina</i> (Hartig) Rehd.	38
	* <i>P. deltoides</i> Marsh.	38
	<i>P. deltoides</i> var. <i>missouriensis</i> Henry	38
	× <i>P. gelrica</i> Houtz.	38
	<i>P. nigra</i> L.	38
	<i>P. nigra</i> var. <i>italica</i> Muenchh.	38
	* <i>P. nigra</i> var. <i>betulifolia</i> (Pursh) Torr.	38
	* <i>P. nigra</i> var. <i>plantiensis</i> (Simon-Louis) Schneid.	38
	× <i>P. robusta</i> Schneid.	38
	**× <i>P. Rasumowskyana</i> Schneid.	38
	*× <i>P. Sargentii</i> Dode	38

** Determination made by the writer from root tip preparation.

* Determination made by the writer from meiotic preparations.

polyploidy within that species. In Sweden, where *P. tremula* has been studied most extensively, nine clones of the triploid form have been discovered (Nilsson-Ehle, 1936; Muntzing, 1936; Blomquist, 1937; Tome-torp, 1937; Johnsson, 1940). One tetraploid form of *P. balsamifera* (= *P. deltoides*?) was reported by Blackburn and Harrison in 1924. Meurman (1925) thinks it likely that some species other than *P. balsamifera* was examined. Although it is true that workers since 1924 have found this species to be a diploid, it is possible that it may also exist in the tetraploid form. Johnson (1939) lists *P. Simonii* as having the unreduced number of seventy-six chromosomes. However, Meurman (1925), who first investigated this species, stated that it is probably a hybrid and due to this fact frequently shows thirty-eight univalent chromosomes at meiotic metaphase. Material investigated in the present study showed a reduced number of nineteen.

Polyloid forms of *P. tremula* have been produced by different investigators. A tetraploid form of this species resulted from the crossing of two triploid forms (Nilsson-Ehle, 1938). Similarly, tetraploids and individuals possessing all the chromosome numbers from nineteen to thirty-eight have been obtained from crosses of diploid and triploid forms of *P. tremula* (Johnsson, 1940).

The chromosomes of *Populus* are small and of varying size. Blackburn and Harrison (1924) made the first observations on size of meiotic chromosomes in *P. tremula*. Here they found that the chromosomes were "... of unequal dimensions; nine were small ones of more or less uniform size; nine others, larger than these, formed a graded series beginning with a member of just a little greater volume than the individual of the first group, and ending with one more than four times its volume. Lastly there was a single chromosome, obviously compound in structure, nearly always appearing in a flat plate as four-lobed, equalling in volume, if not exceeding, that of any two of the other eighteen." These observations were found to apply to *P. nigra* also. The studies were made on meiotic chromosomes at metaphase and anaphase I. Meurman (1925) thought there were two groups of nine chromosomes, nine smaller and nine larger, each group varying within itself. In *P. balsamifera* and *P. trichocarpa* one of the chromosomes was noted as being twice the size of any of the rest. Erlanson and Hermann (1927) saw a similar size classification in *P. tremuloides*. Muntzing (1936) and Johnsson (1940) agree that in *P. tremula* one of the bivalents is much larger than other chromosomes of the set. Nakajima (1937) speaks of a particularly long chromosome in *P. Sieboldii*, while van Dillewijn finds a "giant chromosome" in the meiotic configurations of *P. nigra*, *P. nigra* var. *italica*, *P. brabantica*, *P. gelrica*, *P. robusta*, *P. deltoides* var. *missouriensis*, *P. serotina*, and *P. alba*.

No measurements have been made during this investigation of the size of mitotic chromosomes of *Populus*. However, an examination of root tip chromosomes of *P. tremula*, as illustrated by Muntzing (1936) and Johns-

son (1940), would indicate that they range in size from approximately 0.75 to 2.1 μ . Since the chromosomes are quite small and numerous, studies of chromosome morphology at mitotic divisions are extremely difficult. An attempt was therefore made to study the prophase stages of meiosis. Fig. 1 shows a pachytene stage in the hybrid *P. nigra* \times *P. trichocarpa*. Due to the difficulties involved in making accurate measurements, the lengths are to be regarded as approximations. However, it can be seen from the idiogram (Fig. 2) that there is no "giant chromosome" apparent at this stage. Neither can there be any division of the chromosomes into two groups of nine, one composed of small and one of large chromosomes. There is, rather, a gradual increase in size from about 8.5 to about 30.6 μ in length at this stage. There are one group of three chromosomes and two groups of two chromosomes which are of exactly the same length, a fact which may be of some significance. The discrepancy in reports on the comparative lengths of prophase and metaphase meiotic chromosomes may be due to a differential rate of contraction of the chromosome during the prophase stages. The preparations did not stain in such a way as to show the spindle insertion point.

The genus *Populus* is dioecious. For this reason it might be expected to be the subject of investigation seeking to determine whether or not sex-chromosomes are present in plants. Blackburn and Harrison (1924) first described a heteromorphic chromosome pair in the meiotic chromosomes of *P. tremula* as consisting of a medium sized and a small member. In subsequent investigations the same was found to be true in the case of *P. nigra*. Meurman (1925) seems to have been the first to designate the larger of this chromosome pair as an X chromosome and the smaller as a Y. Thus the male in *Populus* is XY, the female XX, making the condition existing in this genus analogous to that prevailing in most animals. He was able to demonstrate a heteromorphic chromosome pair in the male trees of the species *P. trichocarpa*, *P. balsamifera*, and *P. Simonii*. Erlanson and Hermann (1927), investigating the cytology of perfect flowers in a specimen of *P. tremuloides*, found a heteromorphic pair present at the meiotic divisions similar to that which they saw in the monoecious form of the same species. Nakajima (1937) found that a heteromorphic chromosome pair exists in *P. Sieboldii*.

Muntzing (1936) points out that, since the triploid forms which exist in certain species of *Populus* must have arisen from the union of two gametes, one reduced and one unreduced, we might expect intersexual forms. None, however, has been found. Peto (1938) found no heteromorphic chromosome pair which was present consistently. However, heteromorphic pairs were found in hybrids, and in such instances he thinks that their presence might be explained on the basis of structural differences involved in species differentiation.

Although a special study of sex-chromosomes has not been made a part of this investigation, it may be said that no definitely heteromorphic chromosome pair has been found consistently in any of the species or

hybrids studied. *Fig. 10* shows what appears to be a heteromorphic bivalent similar to those used as illustrations of sex-chromosomes in *Populus* by different authors. It would seem that a demonstration of the presence or absence of a heteromorphic pair at meiosis in a pistillate tree might offer some proof of the existence of sex-chromosomes in this genus. Only one investigation of female trees has been made with this point in mind. Blackburn (1926) states, in reference to *P. tremula*, "I am able to state in regard to the female only that all pairs appear to be equal." A study of meiotic prophase chromosomes, where conditions are most favorable for the detection of morphological differences among the chromosomes, has thus far revealed no strikingly different homologues.

Lawrence (1931) suggests that in general those families with high chromosome numbers, such as the Salicaceae, will be found to be secondary polyploids. Secondary polyploids, according to the definition of Darlington and Moffett (1930), are "... homozygous allopolyploids in which some chromosomes of the basic set are present more frequently than others." Some examples of such genera are *Pyrus* (Darlington and Moffett, 1930), *Acer* (Meurman, 1933), and *Dahlia* (Lawrence, 1931).

Cytologically, secondary polyploids may be recognized by the appearance of a secondary association of chromosomes at either pro-metaphase I or II of the meiotic divisions. The presence of more than two genetically similar chromosomes will result in the formation of occasional multivalent chromosome configurations at the meiotic metaphase I. Further, if these chromosomes are genetically similar it might be expected that they would be morphologically similar, also.

Lawrence (1931) found evidence of secondary association of chromosomes on examination of illustrations of the meiotic chromosomes of species of *Salix* published by Blackburn and Harrison (1924). Van Dillewijn (1940), working on *Populus*, found secondary association of chromosomes in the case of *P. nigra* and *P. nigra* var. *italica*. On this basis he divides the chromosomes into three groups of three each, four groups of two each, and an additional group composed of the "giant chromosome" associated with a smaller chromosome. From this latter association he concludes that the giant chromosome is formed from the union of two smaller chromosomes and that the group as a whole is a group of three. There are thus eight groups in all, giving a basic ancestral number of eight to this genus. Of the original eight chromosomes, four have been duplicated and four triplicated, while within one group of three chromosomes, two have become fused.

Additional evidence that *Populus* is a secondary polyploid is given by the rare occurrence of trivalent formations in the meiotic metaphase of certain diploid hybrids (Table VIII) and the similar occurrence of occasional quadrivalents in the triploid form of *P. alba* (Table III). An examination of the idiogram (*Fig. 2*) does not reveal the similarity in chromosome size which one would expect from van Dillewijn's account of secondary association. Certain members of the chromosome complement are of exactly the

same length. However, on a purely morphological basis it is impossible to obtain the grouping of chromosomes to give eight as the basic number.

There seems to be evidence that the genus *Populus* is of polyploid origin, but obviously there must be a more detailed study before the actual basic number can be determined with any certainty.

CYTOLOGY OF SPECIES

According to Chamberlain (1897), the stamens of *Salix* pass the winter in the spore mother cell stage. He inferred that this was likewise the case in *Populus*. The present work confirms this, for catkins collected in December and early February of 1940 showed the pollen mother cells in a resting condition.

The rate of the meiotic divisions in all species is quite rapid. All stages from first meiotic division to the stage where free immature pollen grains are seen may take place within a space of from twenty-four to thirty-six hours.

The instigation of the meiotic divisions is usually correlated in this genus with the development of anthocyanin pigment in the anthers. Further, the sequence of these divisions and consequently of pollen formation within the catkin seems to be constant within the species and even within the sections of the genus. Erlanson and Hermann (1927) noted that in normal male catkins of *P. tremuloides* the divisions began in the stamens at the base of the catkin and continued regularly toward the tip.

In general there seem to be two types of order of flowering. In type I the meiotic divisions are instigated at either a central or basi-central position and proceed toward the tip and base of the catkin. In type II the divisions begin at the tip of the catkin and proceed toward the base. In the seventeen species and varieties examined, the type was constant within a section of the genus. Type I was found in the sections *Leuce* and *Tacamahaca*, while type II was typical of the section *Aegeiros*. The natural hybrid $\times P. berolinensis$ was aberrant, for while belonging to the section *Aegeiros* it was of type I.

Observations made at the time of anther dehiscence bear out these results, for it was noted that those species belonging to type I shed the pollen at the basal end of the catkin first, while in type II the reverse was true. Meiotic divisions within a pollen sac are usually at the same stage, although two successive stages may be present. In general, the same may be said of all the anthers in one flower. However, in hybrids some irregularities have been observed. Meurman (1925) noted that in *P. Simonii*, which is probably a hybrid, stages from prophase I to telophase I inclusive were often found in the same anther sac. Erlanson and Hermann (1927) found a similar condition in the anther sacs of perfect flowers in *P. tremuloides*.

The first and second meiotic divisions, with few exceptions, are regular in the true species of *Populus* (Figs. 8-15). The picture is diagrammatic in its simplicity and regularity.

TABLE 3.
CHROMOSOME PAIRING AND POLLEN STERILITY IN *POPULUS* SPECIES.

Species	Pairing Relationship				Sterility %
	I	II	III	IV	
<i>P. acuminata</i>	0.80	18.60	0	0	45
<i>P. adenopoda</i>	0.40	18.80	0	0	19
<i>P. alba</i> (diploid)	0	19.00	0	0	3
<i>P. alba</i> (triploid)	10.56	13.52	5.56	0.68	23
<i>P. deltoides</i>	0	19.00	0	0	2
<i>P. grandidentata</i>	0	19.00	0	0	2
<i>P. koreana</i>	0.50	18.75	0	0	12
<i>P. laurifolia</i>	0.40	18.80	0	0	40
<i>P. nigra</i>	0	19.00	0	0	3
<i>P. nigra</i> var. <i>italica</i>	0	19.00	0	0	4
<i>P. Sargentii</i>	0	19.00	0	0	7
<i>P. tremuloides</i>	0	19.00	0	0	2

TABLE 4.
CHROMOSOME PAIRING AND POLLEN STERILITY IN A SPECIES OF *POPULUS*
FROM WHICH FLOWERING BUDS WERE FORCED IN THE GREENHOUSE
FOR DIFFERENT PERIODS OF TIME.

Date of collection	Date at which meiosis took place	Chromosome pairing at meiosis			Pollen sterility %
		I	II	III	
January 24	February 2	7.92	15.04	0	70
March 9	March 12	7.32	15.28	0.04	72
March 23	March 23	7.80	15.10	0	65

Table III gives the pairing relationships observed in a number of species. The counts are based on the study of twenty-five metaphase or late diakinesis configurations for each species, while the sterility counts were made on the basis of a count of one thousand pollen grains for each species.

The material for study was obtained from the *Populus* collection in the Arnold Arboretum. Flowering branches were brought into the greenhouse over the period of February to April and forced into flower. The results might be criticized on the basis that forced material might not behave as normally developed material. However, Nohara (1924) found in pollen studies of *Salix* sp. that results obtained from forced pollen did not differ either in percentage of perfect grains or in viability from that collected in the field. That forcing does not affect chromosome pairing and pollen sterility in *Populus* may be seen from Table IV, where collections of *Populus* sp. (probably a hybrid) made over the period January to March are compared in regard to chromosome behavior and pollen sterility.

Chromosome pairing was complete in most cases where pure species

were studied. This pairing was so intimate that the different members of the pair could be distinguished only with difficulty. Occasional univalent chromosomes were encountered, as for example in *P. laurifolia* and *P. adenopoda*. Apparently this lack of pairing at metaphase I was the result of a precocious separation due to failure or early terminalization of chiasmata rather than to lack of homology between the chromosomes concerned. In this connection Johnsson (1940) reports that in sixteen clones of diploid *P. tremula* examined, four clones showed metaphase I plates having varying numbers of univalents. This is attributed to the influence of external conditions, such as temperature, on meiosis.

Diakinesis proved to be an advantageous stage for study, for at this stage the chromosomes are widely scattered over the entire area of the cell. The nucleolus is usually still present at this stage (*Fig. 8*) and may in some cases remain visible until the early metaphase. However, in those cases where the nucleolus persists until late diakinesis, it shows an irregular outline and a light staining reaction indicative of dissolution. Van Dillewijn (1940) finds that in *P. brabantica*, a natural hybrid, the nucleolus is still visible at the metaphase in some cells, either on the plate or near the plate, in the cytoplasm.

One chromosome is invariably associated with the nucleolus (*Figs. 1, 8, 16*) and is easily distinguished from the remaining chromosomes of the complement, since it is somewhat condensed and darker staining than the rest. The association of one particular chromosome of the complement with the nucleolus has been described by several writers, including Heitz (1931), Sax (1932), and Smith (1933).

In many of the species studied it was noted that the nucleolus possessed a protuberance or knob. Rarely more than one of these was present per nucleolus. A similar condition was described in *P. nigra* by van Dillewijn (1940). According to this writer no protuberance is visible on the nucleolus in the early prophase, but as the prophase progresses a bud develops until it sometimes reaches the dimensions of a nucleolus itself. It seems to the present writer that the knob is first visible in very early prophase and that it reaches its maximum development at approximately the pachytene stage. No difference in size of the knob was noticed between pachytene and early diakinesis. By late diakinesis the knob began to disappear along with the nucleolus proper. In all cases where the nucleolus possesses a knob, the associated chromosome is located at the junction of the knob and nucleolus (*Fig. 1*).

The percentage of nucleoli which showed knobs differs in different species. In *P. deltooides* about seventy-seven per cent, in *P. alba* (diploid) about forty per cent, and in *P. nigra* about eighty percent showed knobs. In *P. alba* the knobs are quite small and rarely approach those of *P. nigra* and *P. deltooides* in size.

The situation where one finds a knobbed protuberance of the nucleolus has been reported but rarely in the flowering plants. Selim (1930), Nandi (1936), and Parthasarathy (1938) report a somewhat similar condition

in *Oryza*, as do Paul (1937) in *Tamarindus* and Iyengar (1939) in *Cicer*. McClintock (1934) reports a reciprocal interchange in *Zea Mays*, produced by x-ray treatment involving the nucleolus organizer, which produces a condition similar in appearance to that described here.

Following telophase I the nuclei are reorganized and the second meiotic division follows in a regular manner.

As is the case in simultaneous pollen cell formation, the cell wall is formed by a furrowing process. This is the method most commonly found in the flowering plants. A condition similar to that which occurs in *Populus* has been described in *Nicotiana* by Farr (1916). The furrows form along the equator of each spindle, extending from the periphery to the center of the pollen mother cell, eventually cutting it into four microspores. Previous to the appearance of these furrows, there appears to be a more or less hyaline area present in the center of the cell, presumably caused by a migration of the protoplasmatic granules away from this particular region. This hyaline area extends in four arms from the center to the periphery, marking the future position of the furrows. This seems somewhat comparable to the condition found in *Melilotus* (Caster, 1925), where similar hyaline areas appeared, caused by a vacuolation of the cytoplasm. Whether or not the hyaline area in *Populus* is caused by a vacuolation must be determined by a more critical examination aided by differential staining methods.

The furrowing process seems to be easily upset. In many cases in hybrid material and in the triploid form of *P. alba* it appears that only one furrow formed, thereby cutting the pollen mother cell into dyads instead of tetrads, although the dyads are themselves binucleate. Occasionally the furrowing process was observed to fail entirely, or it was of such a nature that three microspores instead of the usual four were formed. The significance of such aberrant furrowing is indeed great, if such spores are functional. Numerous examples of such irregularities in microspore formation in *Populus* have been described (Peto, 1938; van Dillewijn, 1940).

A fairly wide variation is seen in the pollen sterility of the pure species studied. In general, these species which showed some univalent chromosomes were the most sterile, but the univalent frequency is hardly sufficient to account for the sterility encountered. Apparently genetic and environmental factors are also involved.

The triploid form of *P. alba*, with an unreduced chromosome number of fifty-seven, shows, as one would expect, a varying number of univalents, bivalents, and trivalents. It also shows quadrivalent formation to some extent (Table III), the significance of which has already been commented upon. It is surprising that the pollen sterility of this triploid is less than that of some of the diploid species studied.

Pollen fertility reported for various triploid forms has been summarized in Table V. Peto (1938) has commented upon this high fertility. It is his opinion that this is merely apparent, and he assumes that the genetically unbalanced pollen grains deteriorate rapidly following their

TABLE 5.

POLLEN STERILITIES IN TRIPLOID FORMS OF *POPULUS* SPECIES.

Triploid Species	Per cent Fertility	Authority
<i>P. tremula</i>	58-75	Johnsson, 1940
<i>P. tremula</i>	44	Muntzing, 1936
<i>P. alba</i>	63	Peto, 1938
<i>P. alba</i> var. <i>aureo-intertexta</i>	94	Peto, 1938
<i>P. alba</i>	67	Smith, 1942

formation. In the pollen slides which he examined, he observed numerous tiny specks which he interpreted to be degenerate pollen grains. It has been shown, however, that in the cross of a triploid \times a diploid and a triploid \times a triploid, *P. tremula*, progeny with intermediate chromosome numbers varying from thirty-eight to seventy-six can be obtained (Johnsson, 1940; Bergstrom, 1940). This fact seems to show that unbalanced pollen grains in at least one species of *Populus* can survive. It has been shown that the genus *Populus* is probably a derived polyploid (van Dillewijn, 1940, and the present study). If this is the case, then certain chromosomes and thus certain combinations of genes are duplicated within the basic set. This condition would be exaggerated in the case of a triploid form, where the basic set of nineteen chromosomes is present three times. In a situation of this sort, it might be expected that pollen sterility due to duplications and deficiencies of whole chromosomes would not be apparent, for it is conceivable that spores lacking certain duplicated chromosomes would still have a functional set of genes.

On the basis of the pairing relationships of the chromosomes at meiosis, it is apparent that the triploid forms of diploid species thus far reported are autotriploids (Muntzing, 1936), which probably arose through the union of a diploid with a haploid gamete.

Studies of the first and second meiotic divisions and the development of the immature microspores have been made by different writers. However, little work has been done on the further development of the male gametophyte. Chamberlain (1897), working with *P. monilifera* (probably *P. deltoides*), reports that the division of the microspore nucleus into the tube and generative nuclei takes place in the pollen grain relatively early, before the tapetal cells of the anther sac degenerate. He describes a rather unusual condition in that two divisions of this pollen grain nucleus occur. On the conclusion of the first division, the smaller of the daughter nuclei is cut off from the other by a cell wall and degenerates. The remaining nucleus then divides again to form the generative and tube nuclei. He concludes by stating, "Since spores already upon the stigmas showed no further differentiation, the division of the generative cell which presumably takes place, although I was not so fortunate as to observe it, must occur after the pollen tube begins to form."

If the condition described by Chamberlain, in which an extra prothallial cell is produced in the pollen grain, is correct, then it is unique, as far as is known in the Angiosperms, and thus of very special interest. Consequently an attempt was made to follow the microspore development up to the production of the gametes. In this part of the work the species *P. deltoides*, *P. acuminata*, and *P. adenopoda* were used. It was possible to demonstrate the first microspore division by aceto-carmin smears (Fig. 3). However, shortly after this division occurs, the pollen wall becomes so opaque that further observation by this method becomes impossible. Further study was made by embedding in paraffin, sectioning, and staining with haematoxylin. A second division within the pollen grain was not observed. The mature pollen grains examined contained two nuclei and there was no visible remnant of a disintegrating nucleus. However, occasional cases, both in *P. acuminata* and *P. adenopoda*, showed a third nucleus within the pollen grain. Since these species show some irregularity at metaphase I (Table III), it is possible that these irregularities might account for this third nucleus.

The development of the pollen tube in the species *P. deltoides*, *P. laurifolia*, *P. acuminata*, and *P. adenopoda* was investigated by placing freshly shed pollen from these species on slides coated with a mixture of agar-agar, gelatin, and sugar, as described in the section on technique. The pollen germinates almost immediately. As a rule the tube nucleus emerges first and the generative nucleus follows. The appearance of the generative nucleus after its emergence from the pollen grain is such that the chromosomes may be distinguished within it. In certain cases it would seem that the term generative cell should be used rather than generative nucleus. The division of the cell takes place from ten to fifteen hours after germination of the pollen grain. Different stages in the development of the pollen tube are shown in Figs. 4-7.

HYBRIDIZATION IN *POPULUS*

Natural hybrids are of frequent occurrence within the genus *Populus*. Johnson (1939) lists sixteen such interspecific hybrids. Rehder (1940) lists sixteen hybrids which have been given species or varietal names but does not include all those listed by Johnson. In all, about twenty-five natural interspecific hybrids have been reported in the genus.

Among the first interspecific hybrids to be described in this genus were many which occurred in botanic gardens when an introduced species was planted near a native species or when two introduced species were planted together. \times *Populus berolinensis*, the hybrid *P. laurifolia* \times *P. nigra* var. *italica*, which originated in the Botanic Garden of Berlin before 1870, is an example of this. \times *Populus canadensis* and its varieties and \times *P. robusta* are further examples. Peto (1938) reports similar hybrids in Canada between the European species *P. alba* and the native species *P. grandidentata* and *P. tremuloides*. It has been noted that female trees of species which have no male trees in the vicinity set viable seed. *P. Maximowiczii* is a good example of this fact, for in the Arnold Arboretum

it sets seed, some of which produce hybrid seedlings, although there are no male trees of this species in North America.

At different times natural hybrids have been described from the field. This has been especially true in eastern Asia and North America, where the number of species of *Populus* is most abundant. From China the "species" *P. Simonii* is probably a natural hybrid, and $\times P. Woobstii$ is thought to be the cross *P. laurifolia* \times *P. tristis*. In order to determine the actual extent of natural hybridization among the North American species, a survey was made of the geographic distribution of the principal species and their natural hybrids, based upon a study of the herbarium sheets of *Populus* in the herbarium of the Arnold Arboretum.

\times *Populus Andrewsii* represents the cross *P. Sargentii* \times *P. acuminata*. It has been collected from two stations in Colorado, Welsenberg and Montrose, both within the southern part of the overlap range of the parent species, which are also represented from these stations. \times *Populus Parryi* has been collected from three localities in California, Canada de las Uvas, San Bernando, and Owens Lake. It is the result of the cross *P. Fremontii* \times *P. trichocarpa*. \times *Populus Jackii* (*P. Tacamahaca* \times *P. deltoides*) has been collected from some twenty localities scattered over southern Quebec and Ontario, Vermont, and New York. This area represents but a small part of the overlap range. In many cases both parents have been collected from the same localities as the hybrid. The hybrid *P. grandidentata* \times *P. tremuloides* is somewhat similar in both these respects. It has been collected at twelve stations from Quebec and New England west to Ohio. The probable hybrid *P. acuminata* \times *P. Wislizeni* has been collected from one locality, Silver City, New Mexico. The cross *P. candicans* \times *P. Tacamahaca* is represented by one collection made in the Arnold Arboretum. Four of these natural hybrids are the result of intersectional crosses, while two are crosses between species belonging to the same section, *P. grandidentata* \times *P. tremuloides* and *P. candicans* \times *P. Tacamahaca*.

Any conclusion drawn from this study of natural hybridization are necessarily limited by the fact that only those herbarium sheets contained in the Arnold Arboretum herbarium were examined. In no case does the distribution of the hybrid cover the entire range of overlap between the parent species. In two cases the hybrid is represented by but two collections. From the numerous artificial hybrids reported one might expect to find natural hybrids widespread. Their relative scarcity may be due to several reasons. 1. These hybrids are capable of reproducing themselves only through vegetative means. 2. Hybrids are scarce in those regions in which relatively little collecting has been done and abound in those regions where abundant collections have been made. 3. The most probable reason, however, is that while growing in the same general geographic region, the parent species may occupy different ecological habitats and overlap rather infrequently. An attempt will be made in a later part of this work to account for this lack of hybridization on the basis of

TABLE 6.

NATURAL AND ARTIFICIAL INTERSPECIFIC HYBRIDS WITHIN THE
GENUS *POPULUS* ARRANGED TO SHOW CROSSING
WITHIN AND BETWEEN SECTIONS.

Leuce × Leuce	Leuce × Tacamahaca	Leuce × Aegeiros	Tacamahaca × Tacamahaca	Tacamahaca × Aegeiros	Aegeiros × Aegeiros
14	2	4	7	28	28

edaphic isolation. However, it can be shown that, in spite of such isolation, most of the possible hybrids occur between species of the same geographic region.

Artificial interspecific hybrids in this genus have been produced in abundance by different workers. Smith and Nichols (1941) list eighty-one artificial interspecific hybrids which have been produced and described by Henry (1914), Heimbürger (1936, 1940), von Wettstein (1933), Schreiner (1934), and others. Table VI shows how these hybrids, along with the known natural hybrids, are distributed between and within the sections of the genus. The significance of this distribution will be discussed in relation to speciation in a later part of this work.

Material for a cytological study of some of the artificial hybrids produced by Schreiner and his collaborators for the Oxford Pulp and Paper Company was obtained from Dr. E. J. Schreiner of the Northeastern Forest Experiment Station. The number of hybrids investigated was unfortunately limited to those which happened to come in flower over the period 1939-1941. Most of these were not the wide crosses which were desired for study. Those hybrids from which collections were made are described in Table VII, along with the natural hybrids investigated. The latter were obtained from the collections in the Arnold Arboretum.

In all, twenty-five metaphase I, anaphase I and, in some cases, anaphase II plates were analysed to determine the extent of chromosome pairing and to study the various abnormalities which follow asynapsis. In each case the pollen sterility was determined by a count of two thousand pollen grains. In this connection it might be noted that the sterility was variable, differing somewhat with different collections from the same tree taken at the same or different times. Where possible, prophase stages of meiosis were studied to obtain some idea of chromosome pairing at the earlier stages. Table VIII summarizes the data on chromosome pairing and pollen sterility obtained from both the natural and artificial hybrids studied.

CYTOLOGY OF HYBRIDS

In order that chromosomes may pair at meiotic metaphase, three general conditions must be realized: first, that genetically similar chromosomes are present; second, that asynaptic genes do not influence the pair-

TABLE 7.

A LIST OF THE NATURAL AND ARTIFICIAL HYBRIDS OF *POPULUS*
INVESTIGATED, WITH DESCRIPTIONS OF THE CROSSES
WHICH THEY REPRESENT.

Name or number*	Cross	Description of cross
1. $\times P.$ <i>Andrewsii</i>	<i>P. Sargentii</i> \times <i>P. acuminata</i>	Between sections Tacamahaca & Aegeiros; both parents native to North America.
2. $\times P.$ <i>berolinensis</i>	<i>P. laurifolia</i> \times <i>P. nigra</i> var. <i>italica</i>	Cross within the section Aegeiros between geographically isolated species.
3. $\times P.$ <i>canadensis</i>	<i>P. deltoides</i> \times <i>P. nigra</i>	Cross within the section Aegeiros between geographically isolated species, <i>P. deltoides</i> from North America, <i>P. nigra</i> from Europe & western Asia.
4. $\times P.$ <i>canadensis</i> var. <i>Eugenei</i>		
5. $\times P.$ <i>canadensis</i> var. <i>regenerata</i>		
6. $\times P.$ <i>Jackii</i>	<i>P. Tacamahaca</i> \times <i>P. deltoides</i>	Intersectional cross Tacamahaca \times Aegeiros; parents native to North America.
7. <i>P. nigra</i> var. <i>plantierensis</i>	<i>P. nigra</i> var. <i>italica</i> \times <i>P. nigra</i> var. <i>betulifolia</i>	Within the section Aegeiros; both parents varieties of the same European species.
8. $\times P.$ <i>robusta</i>	<i>P. angulata</i> \times <i>P. nigra</i> var. <i>plantierensis</i>	Within the section Aegeiros between geographically isolated species.
9. <i>P. Simonii</i>	Supposed true species; native to north China.	
10. $\times P.$ <i>Woobstii</i>	<i>P. laurifolia</i> \times <i>P. tristis</i> ?	Cross within the section Tacamahaca; parents native to western Asia.
OP-64 OP-74 OP-113	<i>P. charkoviensis</i> \times <i>P. plantierensis</i>	Both parents probably hybrids; cross might be written thus: (<i>deltoides</i> \times <i>nigra</i>) \times (<i>nigra</i> var. <i>italica</i> \times <i>nigra</i> var. <i>betulifolia</i>).
OP-96 OP-97 OP-98 OP-118	<i>P. nigra</i> \times <i>P. laurifolia</i>	Cross between sections Tacamahaca and Aegeiros; between geographically isolated species.
OP-99	<i>P. charkoviensis</i> \times <i>P. clone robusta</i>	Both parents probably hybrids within section Aegeiros; (<i>deltoides</i> \times <i>nigra</i>) \times (<i>angulata</i> \times <i>nigra</i> var. <i>plantierensis</i>).

TABLE 7 (*continued*).

Name or number*	Cross	Description of cross
OP-102	<i>P. nigra</i> × <i>P. bero-</i> <i>linensis rossica</i>	Parents within the section <i>Aegeiros</i> ; male parent hybrid; <i>deltoides</i> × <i>nigra</i> var. <i>italica</i> .
OP-103	<i>P. nigra</i> × <i>P. nigra</i>	Control cross.
OP-104	<i>P. nigra</i> × <i>P. trichocarpa</i>	Intersectional cross between geo- graphically isolated species.
OP-105	<i>P. nigra baatanicorum</i> <i>vitrum</i> × <i>P. volga</i>	Crosses between 2 closely related varieties of <i>P. nigra</i> .
OP-106	<i>P. nigra baatanicorum</i> <i>vitrum</i> × <i>P. plantierensis</i>	
OP-109	<i>P. Rasumowskyana</i> × <i>P. caudina</i>	Female parent probably the hybrid <i>P. laurifolia</i> × <i>P. nigra</i> ; parents probably belong to section <i>Aegeiros</i> .
OP-110	<i>P. Rasumowskyana</i> × unidentified cotton-wood	
OP-111	<i>P. charkoviensis</i>	<i>P. charkoviensis</i> probably hybrid <i>P.</i> <i>deltoides</i> × <i>P. nigra</i> ; male parent closely related to <i>P. nigra</i> ; both be- long to section <i>Aegeiros</i> .
OP-114	× <i>P. incrassata</i>	
OP-112	<i>P. deltoides</i> × <i>P. deltoides</i>	
OP-116	<i>P. charkoviensis</i> × <i>P. berolinensis</i>	Both parents probably hybrids; (<i>nigra</i> × <i>deltoides</i>) × (<i>laurifolia</i> × <i>nigra</i> var. <i>italica</i>); both belong to section <i>Aegeiros</i> .
OP-117	<i>P. charkoviensis</i> × <i>P. deltoides</i>	(<i>nigra</i> × <i>deltoides</i>) × <i>deltoides</i> ; cross within the section <i>Aegeiros</i> .
OP-119	<i>P. charkoviensis</i> × <i>P. caudina</i>	Female parent probably hybrid; both within section <i>Aegeiros</i> .

* Entries numbered 1-10 are natural hybrids. The remaining entries are artificial hybrids; clone numbers and parentages supplied by Dr. Schreiner.

ing; and third, that, after pairing, chiasmata form in the pachytene chromosomes.

In the present study, while it is recognized that the latter two conditions may play a part in the pairing behavior of the chromosomes at meiotic metaphase, no attempt has been made to study the chiasmata formation in the parental species and hybrids due to the extremely small size of the chromosomes. In general, it was noted that the univalents tend to be the smaller chromosomes of the complement. At this time not enough is known of the genetics of these hybrids to determine to

TABLE 8.

MEIOTIC CHROMOSOME PAIRING, CHROMOSOME NUMBER, INVERSION
BRIDGE FORMATION, AND POLLEN STERILITY IN NATURAL
AND ARTIFICIAL HYBRIDS OF *POPULUS*.

Name or Number	Chro. No.	Metaphase I Analysis			Anaphase I Analysis			Pollen Sterility Per cent
		I	II	III	L	B	M	
1.	19	0.72	18.64	0	0.72	0.14	1	20
2.	19	5.30	16.20	0.10	2.00	0.12	1	57
3.	19	1.84	18.08	0	0.60	0.12	2	17
4.	19	4.92	16.48	0.04	2.90	0.33	3	63
5.	19	3.92	17.04	0	3.69	0.04	1	56.5
6.	19	2.40	17.80	0				62
7.	19	0	19.	0				6
8.	19	6.00	16.	0	2.50	0.13	2	75
9.	19	1.76	18.12	0				31
10.	19	14.24	11.88	0				80
OP-64	19	0.28	18.86	0	0.16	0.23	1	5
OP-74	19	0.64	18.68	0	0.20	0.08	1	24
OP-113	19	1.14	18.43	0	0.16	0.23	1	22.4
OP-96	19	0.40	18.80	0				20
OP-97	19	1.00	18.50	0	0.40	0.20	1	16
OP-98	19	0.20	18.90	0				10
OP-118	19	0.80	18.60	0	0.40	0	0	25
OP-99	19	1.00	18.50	0				26
OP-102	19	1.20	18.40	0				20.4
OP-103	19	0.20	18.90	0				5
OP-104	19	0.80	18.60	0	0.66	0.33	2	23
OP-105	19	0.20	18.90	0	0.26	0.06	1	10
OP-106	19	0	19.	0	0.06	0	0	6
OP-109	19	0.60	18.70	0	0.86	0.53	3	12
OP-110	19	2.20	17.90	0	1.25	0.30	2	40.5
OP-111	19	0.20	18.90	0	0.40	0	0	
OP-114	19	0.40	18.80	0				
OP-112	19	0.20	18.90	0	0.46	0	0	6
OP-116	19	3.00	17.50	0				
OP-117	19	1.40	18.30	0	1.00	0.26	3	
OP-119	19	0.76	18.62	0	0.44	0.12	2	35

I, II, and III under metaphase analysis refer to the average number of univalents, bivalents, and trivalents per cell. L, B, and M under anaphase analysis refer to the average number of lagging chromosomes, average number of inversion bridges and maximum number of inversion bridges per cell.

what extent asynaptic genes influence pairing relationships. Environmental factors are also known to cause asynapsis.

Two classes of genetic dissimilarity of the chromosomes are recognized. The first, which is purely genic and presumably arises through gene mutation, is usually not assigned a large role in asynapsis. The second type of dissimilarity is structural and is brought about by rearrangements of genic material within the chromosome. It is usually assumed that this type of dissimilarity plays the major role in asynapsis.

Darlington (1937) discusses the classification of hybrids at some length, dividing them into seven classes: numerical, structural, undefined structural, complex, polyploid, numerical-structural, and Mendelian hybrids. Under this classification the interspecific hybrids in *Populus* considered here would be placed in the undefined structural hybrid class, these "... resulting from the union of gametes dissimilar as a result of changes which cannot be defined ... simply because the structural differences between their chromosomes are too slight or too numerous to be detected."

The undefined structural hybrids are further broken down into those which show potentially complete pairing at metaphase I, those which show partial pairing, and those which have a potentially complete failure of pairing. Evidently the interspecific hybrids of *Populus* investigated thus far might be placed in the first two groups, although the larger number belongs to the second, for these hybrids show a partial and always variable pairing.

Numerous examples may be cited for each of the hybrid classes listed above. Among the undefined structural hybrids which show potentially complete pairing are *Salix viminalis* \times *S. caprea* (Haakanson, 1929), *Platanus orientalis* \times *P. occidentalis* (Sax, 1933), and *Catalpa bignonioides* \times *C. ovata* (Smith, 1941). The hybrids *Viola arvensis* \times *V. rothmagensis* (Clausen, 1931) and *Ribes nigrum* \times *R. Grossularia* (Meurman, 1928) are examples of undefined structural hybrids which show partial pairing.

By the cytological examination of the interspecific hybrids from pachytene stage of prophase onward it is possible to demonstrate that a varying number of bivalents and univalents are present (Figs. 1, 18, 21). Within a single hybrid the number of univalents present per cell at metaphase I may vary from none to thirty-eight (Figs. 18, 19, 21). Considering the hybrids studied as a whole, the number of normal cells, normal in the sense that they contained nineteen bivalent chromosomes at metaphase I, varied from four to ninety-six per cent, with an average of fifty-three per cent.

Univalent chromosomes were present in varying numbers in all the hybrids examined. Usually these univalents lie on either side of the metaphase plate (Fig. 18), come onto the plate after the bivalent chromosomes have divided, and then divide (Fig. 21). There is some evidence that some univalent chromosomes do not divide at anaphase I but go to the poles without lagging or dividing. On the basis of an examination of five hundred each of metaphase I and anaphase I figures (twenty-five each of twenty hybrids), it was found that more univalents were present at metaphase I than appeared as lagging univalents at anaphase I. The average was 1.65 univalents at metaphase I as compared to 0.96 univalents at anaphase I. Since no univalent chromosomes were observed dividing at anaphase II it seems likely that those univalent chromosomes which did not divide at anaphase I behave in a normal manner at the following division.

After dividing, the lagging univalents may or may not reach the poles

TABLE 9.

A COMPARISON OF SUPERNUMERARY SPORES AND UNIVALENT CHROMOSOMES IN SPECIES AND HYBRIDS OF *POPULUS*.

Species or hybrid	Univalents per cell	Supernumerary spores per cell
<i>P. deltoides</i>	0	0
<i>P. alba</i> (diploid)	0	0
<i>P. nigra</i>	0	0
× <i>P. Andrewsii</i>	0.72	0.55
× <i>P. berolinensis</i>	5.30	0.32
× <i>P. robusta</i>	6.00	0.47
× <i>P. canadensis</i>	1.84	0.30

in time to be incorporated into the daughter nuclei. If they do not reach the poles they are lost in the cytoplasm (*Fig. 23*). If they are included in the dyad nuclei they are distributed at random to the poles at anaphase II or are lost in the cytoplasm. On the basis of one hundred anaphase II figures analyzed in two hybrids it was found that three times as many univalent chromosomes were lost at anaphase I as there were at anaphase II. The ultimate fate of these univalent chromosomes seems to depend upon the rapidity with which they progress to the poles at both anaphase I and II. In both cases if they reach the poles before the daughter nuclei are formed they are included in these nuclei, otherwise they are left behind in the cytoplasm, where they form either micronuclei or supernumerary spores. Just what determines their fate is not clear. It does not seem to depend upon the number of univalents available, for the nucleus of the supernumerary spore is as small as the micronucleus. The factor determining this may be the position of the univalents at the time of the cell wall formation, those near the microspore nuclei becoming micronuclei and those farther out becoming supernumerary spores.

That the presence of supernumerary spores is correlated with the presence of univalent chromosomes is shown by Table IX.

An anaphase analysis of these interspecific hybrids revealed in nearly every case a varying number of inversion bridges (Table VIII; *Figs. 24-31*). The condition in which a portion of a chromosome is present in the inverted state is one of the most frequently encountered meiotic aberrations. This condition can be detected in plants when a crossover occurs within the heterozygous inversion region, for as a result chromatin bridges are formed at anaphase I. A loop pairing at pachytene is also characteristic. The occurrence of inversions in both plants and animals has been reported by many writers, among them Muntzing (1934), Richardson (1936), and Stebbins (1938). Structural hybridity has not previously been reported in the genus *Populus*. Haakanson (1929) has reported a case of reciprocal translocation in *Salix*.

Following the occurrence of a crossover within the heterozygous inversion, a dicentric chromatid and an acentric fragment should be pro-

duced at anaphase I. The fragment usually lies in the cytoplasm in the vicinity of the bridge and varies in size with the length and position of the inverted region. Only five cases were encountered in these hybrids where the fragment could be seen associated with the bridge (Figs. 25, 30). This is not an unusual condition, for Swanson (1940) finds that in *Tradescantia* fifty per cent of the bridges studied lacked visible fragments. Sax (1937) and Darlington (1937) report a somewhat similar condition. These investigators account for the lack of fragments on the basis of the presence of small subterminal inversions, which result in fragments which are below the limit of visibility or are obscured by other chromosomes of the complement.

It is possible that the number of bridges observed was but a fraction of those which actually occurred, since the bridges formed in the smaller chromosomes would break in very early anaphase or stretch so thinly that they could not be seen. Usually the inversion bridge breaks and the two parts of the chromosome reach the poles, but occasionally the bridge fails to break and remains in the cytoplasm following the first division (Fig. 31).

No bridges were seen in material from control crosses or from the species of *Populus* examined.

It is of interest that van Dillewijn (1940) notes the presence of chromatin strings stretching between the two anaphase plates at late anaphase I in *P. robusta*. Meurman (1933) figures the heteromorphic sex-chromosome pair in *P. Simonii* (a probable hybrid) as lagging at anaphase I and resembling a chromosome bridge. It is possible that what in the past have been taken to be sex-chromosome pairs at anaphase are in reality inversion bridges. This seems especially likely since the members of the heteromorphic pair seem to differ but slightly in size. In the hybrids studied here, the possibility that what appears to be inversion bridges are in reality dividing sex-chromosomes seems to be ruled out in those cases where two or more bridges were seen in a single cell.

In general it may be said that pollen sterility is due to one or more of three possible factors: purely genetic, structural, and environmental. It is not possible to separate these three causes in the case of interspecific hybrids of *Populus*. From an examination of pure species within this genus it is apparent that pollen sterility varies from 2–7 per cent in those species showing complete chromosome pairing and from 19–45 per cent in those species showing a varying number of univalent chromosomes at metaphase I. Presumably the sterility in the first group was due largely to genetic causes, while that of the second group was due to both genetic and environmental causes. Presumably in the case of the interspecific hybrids all three factors contribute to sterility. At present it is impossible to determine to what extent each of these exerts its influence. There does seem to be a correlation between univalent formation and pollen sterility, as had already been noted in the case of the species studied. In general those hybrids with the higher number of univalents show the higher sterilities. The correlation is high, since r equals 0.88.

TABLE 10.

A COMPARISON OF CERTAIN NATURAL AND ARTIFICIAL INTERSPECIFIC
HYBRIDS OF *POPULUS* IN REGARD TO DATE OF ORIGIN, UNIVALENT
CHROMOSOME FORMATION, AND POLLEN STERILITY.

Name or number	Cross	Probable date of origin	Univalents per cell	Percentage of sterility
<i>Natural Hybrids:</i>				
× <i>P. berolinensis</i>	<i>P. laurifolia</i> × <i>P. nigra</i> var. <i>italica</i>	1870	5.30	57
× <i>P. canadensis</i> var. <i>Eugenei</i>	<i>P. deltoides</i> × <i>P. nigra</i>	1850	4.92	63
<i>Artificial Hybrids:</i>				
OP-67	<i>P. nigra</i> × <i>P. laurifolia</i>	1925	1.00	16
OP-114	<i>P. nigra</i> × <i>P. trichocarpa</i>	1925	0.80	23

The failure of chromosome pairing in these hybrids, followed by a loss of chromosomes or unequal distribution of chromosomes to the microspores, results in deficiencies and duplications of entire chromosomes. In the case of deficiencies, at least, this would lead to the sterility of those microspores deficient for one or more chromosomes. The loss of fragments of chromosomes through the formation of inversion bridges would also result in deficiencies for parts of chromosomes.

Peto (1938) notes that the pollen sterility in the hybrids within the section *Leuce* compares favorably with the sterility of the parent species. In the case of the hybrids considered here, it seems that the natural hybrids have an average sterility which is considerably higher than that of the parent species. The artificial hybrids, on the other hand, possess sterilities corresponding to those of the species, ranging from 5–40 per cent with an average of 19.7 per cent. The natural hybrids, however, range from 6–80 per cent with an average of 46.7 per cent pollen sterility.

It is known that the mutation rate increases with age (Cartledge and Blakeslee, 1934, and 1935). It might be expected that those physiological changes in the cell which condition this increased mutation rate might cause an increase in susceptibility to environmental influences, and, in addition, that structural changes occurring over a long period of time might accumulate to produce a greater pollen sterility. Certain natural and artificial interspecific hybrids of *Populus* are compared in Table X.

Some of the common meiotic abnormalities found in the interspecific hybrids of *Populus* have been mentioned. Among these were asynapsis, with subsequent lagging univalent chromosomes at anaphase I and II, and irregularities in cytokinesis within the pollen mother cell which result in dyads, triads, and number of microspores in excess of four. A pre-

TABLE 11.

A COMPARISON OF INTERSECTIONAL WITH INTRASECTIONAL CROSSES OF *POPULUS*, AND OF CROSSES BETWEEN NON-GEOGRAPHICALLY ISOLATED SPECIES WITH CROSSES BETWEEN GEOGRAPHICALLY ISOLATED SPECIES.

Class of hybrid	Number of hybrids	Average number univalents Metaphase I	Average number bridges Anaphase I	Average Per cent Sterility
Crosses within the section	13	3.22	0.19	37.9
Crosses between sections	7	0.90	0.17	25.0
Crosses between geographically isolated species	10	2.52	0.16	36.25
Crosses between non-geographically isolated species	3	5.78	0.14	54.0

cocious furrowing was a common abnormality of this sort. It was not uncommon to find that the furrowing process was well advanced before the completion of the second meiotic division. Muntzing (1936) and van Dillewijn (1940) describe cases of spindle fusion during the meiotic divisions in *Populus*, which result in microspores with the unreduced number of chromosomes. This is a possible cause for the occurrence of autotriploids within the genus. What appears to be a case of a third division in the pollen mother cell before microspore wall formation is shown in Fig. 22. Four spindles have formed and the thirty-eight chromosomes present have apparently been distributed to the poles at random.

DISCUSSION

Cytological and genetical studies of interspecific hybrids have been used by many investigators to establish probable interspecific relationships in plants and animals. The cytological study of species hybrids based upon chromosome configurations and sterility counts has been particularly useful, since it can be used as a basis for the determination of the manner in which speciation has taken place.

In the one varietal hybrid of *Populus* studied, *P. nigra* var. *plantierensis* (*P. nigra* var. *italica* \times *P. nigra* var. *betulifolia*), the chromosome behavior and pollen sterility is comparable to that of a pure species.

Since *Populus* has been subdivided into four sections, and since the species within a section resemble one another more than they resemble those of other sections, it might be supposed that intrasectional hybrids would be more easily obtained and would show a lower percentage asynapsis and pollen sterility than intersectional hybrids. Table XI compares crosses between and within the sections *Tacamahaca* and *Aegeiros*,

which are perhaps less distinctly set off from one another than from the other sections of the genus. From the table it is clear that there is no significant difference in regard to asynapsis and pollen sterility between crosses within and those between these sections.

A glance at Table VI will show that the majority of the crosses are inter- and intrasectional crosses involving species belonging to the two sections *Tacamahaca* and *Aegeiros*. This is to be expected, since these two sections contain more species than do the others. Further, the species producing the better timber trees of the genus are placed in these sections. No hybrids are known either within the section *Leucoides* or between species of this section and those of the other sections of the genus. Interspecific hybrids are known, however, within and between the sections *Leuce* and the sections *Tacamahaca* and *Aegeiros*. Table VI seems to indicate that crosses within the section are more easily obtained than are intersectional crosses (except *Tacamahaca* and *Aegeiros*). Heimbürger (1940) sees a definite limitation to species hybridization based on genetic affinities which cause crossing to follow a series similar to the series aspens — silver poplars — cottonwoods — balsam poplars. However, Johnson (1939) states that there appears to be little limitation to species hybridization within the genus, as far as artificial hybridization is concerned.

A comparison of the cytological behavior of hybrids between geographically isolated species is of interest, inasmuch as it permits a study of the effects of isolation upon speciation over long periods of time. Table XI compares hybrids which result from crossing of geographically isolated species with hybrids resulting from the crossing of non-geographically isolated species, in regard to asynapsis, inversion bridge formation, and pollen sterility. It is apparent that there is no significant difference between the two groups. Species of *Populus* native to North America cross readily with European and Asiatic species to produce hybrids which are as fertile as those resulting from crosses between native North American species.

The term *ecospecies*, defined by Turesson (1922) as uniform types between which crossing is possible with a relatively high degree of fertility but which commonly are prevented from doing so by isolating barriers, either edaphic or geographical, would seem to apply to species of *Populus*. An examination of hybrids between certain species reveals a considerable amount of sterility; however, the F_2 and backcross generations which have been obtained show a segregation indicative of an exchange of genes between the two species.

Species as discrete units can exist as such only by means of some isolating mechanism. Various classifications of these mechanisms have been made (Sax, 1936; Dobzhansky, 1941). In general they may be divided into five classes: edaphic (adaptation to particular local habitats), geographic, physiological (probably genetic, but in this case referring to flowering time), chromosomal (either numerical or structural), and purely genetic.

TABLE 12.

HABITATS AND BLOOMING TIMES OF CERTAIN SPECIES OF *POPULUS*
WHICH OCCUPY THE SAME GEOGRAPHIC REGION.

Species	Physiological blooming time in Arnold Arboretum	Edaphic ecological habitat
<i>P. grandidentata</i>	April 20/40	Moist sandy soil, gravelly hillsides
<i>P. tremuloides</i>	April 20/40	Rich moist soil, borders of streams and swamps
<i>P. deltoides</i>	May 5/40	Low, river-bottomlands
<i>P. Tacamahaca</i>	May 4/40	Low, often inundated river-bottomlands, swamp borders

Considering the three sections of the genus which have been studied, it is clear that artificial hybrids may be made in any direction. The F_1 hybrids have proved to be relatively fertile. However, at this time insufficient data are at hand to determine with certainty the viability of the second generation. It would seem that genetic isolation itself could not be the major factor in isolation of the species.

Autotriploid forms of a number of species within the section *Leuce* have been described. These, though relatively fertile, are unable to preserve their identity. No other polyploid forms are at present known in this genus. Polyploidy (numerical chromosomal isolation) is ruled out as a factor in speciation within this genus. Evidence has been advanced to show that *Populus* is a derived or secondary polyploid, so polyploidy may have played a part in the ancestral differentiation of the genus. The discovery of inversion bridges in the F_1 interspecific hybrids and the asynapsis present in most hybrids indicate considerable structural differentiation of the chromosomes of the different species. But, as in the case of genetic isolation, it does not appear to prevent the crossing of the species or the production of a relatively fertile F_1 generation.

A striking example of physiological isolation is found in this genus. The species included within the section *Leuce* are earlier in blooming time by two to three weeks than are those of the other species of the genus. They are thus definitely set off in nature. This isolation may be overcome artificially (Smith and Nichols, 1941). However, the major factor in isolation of the species of *Populus* seems to be isolation of a geographic and edaphic nature. Both types are essentially the same, geographic isolation being perhaps more complete and on a larger scale than edaphic isolation.

The species *P. grandidentata*, *P. tremuloides*, *P. deltoides*, and *P. Tacamahaca* occupy a somewhat similar area in northeastern United States and the adjoining region of Canada. Table XII summarizes their habitats and blooming times.

Populus grandidentata and *P. tremuloides* are set off from the remaining two species by their time of blooming. Presumably they are themselves isolated by edaphic factors, since their habitats differ somewhat. However, the hybrid *P. grandidentata* \times *P. tremuloides* does occur. Similarly the hybrid \times *P. Jackii* (*P. Tacamahaca* \times *P. deltoides*) occurs rather frequently, although presumably the parental species are separated by edaphic isolation.

A consideration of evidence available would indicate that the first step in speciation in *Populus* may have been a physiological isolation of a group or groups of species from the general population, since the major geographic groups of *Populus* species all contain species belonging to the section *Leuce*. This physiological isolation was in turn followed by geographic and edaphic isolation. The structural-chromosomal differentiation which has taken place since that time has been insufficient to prevent interspecific hybridization and the production of reasonably fertile hybrids.

The slow accumulation of genetic differences through mutation has probably been the major factor in the differentiation of the species of *Populus*, but apparently these species can exist as discrete units only as a result of physiological isolation, in the case of the section *Leuce*, and geographic or edaphic isolation in the case of the individual species.

ACKNOWLEDGMENTS

The writer acknowledges with gratitude the many valuable suggestions and criticisms of Professor Karl Sax, under whose direction this investigation has been carried out. The guidance of Professor Alfred Rehder in the study of the distribution of species of *Populus* and the occurrence of natural hybrids, and the kindness of Dr. Ernst J. Schreiner, in supplying cytological material of the various artificial hybrids, are gratefully acknowledged.

SUMMARY

The chromosome numbers of thirty-eight species, varieties, and natural hybrids of *Populus* have been determined, twelve of which were in confirmation of previous work by other investigators. All species exist as diploids with an unreduced chromosome number of thirty-eight. In the case of three species, all within the section *Leuce*, triploid forms with an unreduced chromosome number of fifty-seven exist.

The chromosomes of the hybrid *P. nigra* \times *P. trichocarpa* at the pachytene stage of the meiotic prophase vary in length from 30.6 to 8.5 μ in length. One group of three and two groups of two chromosomes are of exactly the same length. No heteromorphic chromosome pair which might be interpreted as a sex-chromosome pair has been seen consistently.

The occurrence of secondary association of chromosomes has been noted by other workers. Additional evidence for secondary polyploidy is found in the fact that morphological similarities exist among certain groups of chromosomes and that occasional trivalent associations of

chromosomes are found in hybrids and quadrivalent associations in the triploid form of *P. alba*.

The instigation and progress of the meiotic divisions within the catkin are consistent within the species and within the section of the genus. These divisions are regular as a rule, but in a few species a certain amount of asynapsis and abnormal pollen sterility is encountered. This is not interpreted as due to any genetic dissimilarity between the chromosomes.

One chromosome of the complement is invariably associated with the nucleolus at meiotic prophase. In the majority of cases the nucleolus possesses a knob which projects from the point of attachment of the associated chromosome.

The triploid form of *P. alba* shows a varying number of univalent, bivalent, trivalent, and quadrivalent chromosome configurations at metaphase I. The fact that the pollen sterility of the triploid forms is somewhat less than that to be expected on the basis of univalent formation is accredited to the fact that the basic set of chromosomes is triplicated and thus genetic unbalance, due to the loss of whole chromosomes, is less likely to occur.

Cytokinesis is of the type usually found in cases of simultaneous pollen cell formation. The process seems to be easily upset in the case of triploid forms and interspecific hybrids of *Populus*.

A study of the development of the male gametophyte from the first microspore division up to the time of fertilization shows this to be typical of the process as found in the Angiosperms.

The geographic distribution of the North American species of *Populus* has been investigated, especially as related to the occurrence of natural hybrids. The natural and artificial hybrids which have been reported are arranged in tabular form to show the extent of crossing within and between sections of the genus.

The study of chromosome behavior at meiosis in ten natural and twenty-one artificial interspecific hybrids shows them to be variable in regard to synapsis. They are probably structurally undefined hybrids under Darlington's classification. It has been demonstrated that the chromosomes of the different species have been differentiated structurally and that inversion bridges are of relatively frequent occurrence. Pollen sterility within the artificial hybrids is of the same order as that within the parental species, but that of the natural hybrids is somewhat higher. An attempt is made to explain this fact on the basis of an accumulation of structural changes within the chromosomes over the relatively longer period of time these natural hybrids have been in existence as clones. No significant difference in pollen sterility, univalent formation, or inversion bridge frequency is found when intersectional crosses are compared with intrasectional crosses. Similarly a comparison of crosses between geographically isolated species and non-geographically isolated species reveals no significant difference.

A review of the isolating mechanisms which may operate in this genus seems to indicate that geographic and edaphic isolation are those which

separate the species, although one entire section is set off from the other sections of the genus by a physiological isolation. It seems from the evidence available that differentiation of the species of *Populus* has been brought about by a slow accumulation of genetic differences through mutation. These species can exist as discrete units, however, only through the operation of geographic, edaphic and, in a few cases, physiological isolation. Genetic and structural-chromosomal isolation plays a relatively minor part in species isolation.

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DESCRIPTION OF PLATES

All drawings are at a magnification of $\times 2090$.

PLATE I

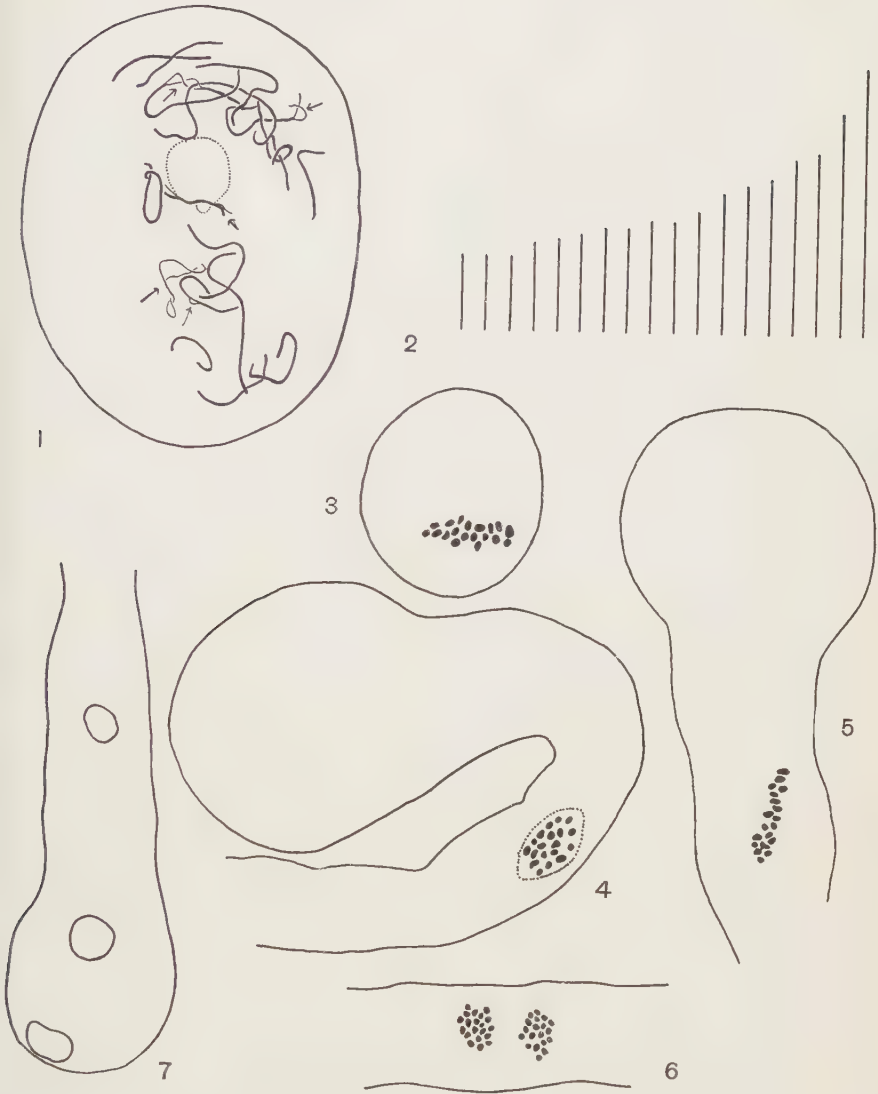
FIG. 1. Pachytene stage of meiosis of the hybrid *P. nigra* \times *P. trichocarpa*. One chromosome is associated with the nucleolus at the junction of the knob and the nucleolus proper. Failure of synapsis is indicated by arrows. Camera lucida drawing. FIG. 2. Idiogram of pachytene chromosomes shown in figure 1. One group of three chromosomes and two groups of two chromosomes are of exactly the same length. FIG. 3. Metaphase of the first microspore division in *P. acuminata*. FIG. 4. Generative nucleus in the pollen tube of *P. laurifolia* twelve hours after germination. FIG. 5. Metaphase of the division of the generative nucleus in the pollen tube of *P. laurifolia*. FIG. 6. Anaphase of the division of the generative nucleus in the pollen tube of *P. laurifolia*. FIG. 7. Pollen tube showing tube nucleus (at lower end of tube) and two gametes of *P. deltoides*.

PLATE II

FIG. 8. Late diakinesis in *P. Sargentii*. Nineteen bivalent chromosomes present, one of which is associated with the nucleolus. FIG. 9. Metaphase I in *P. acuminata*, showing nineteen bivalent chromosomes. FIG. 10. Metaphase I in *P. adenopoda*, with "heteromorphic chromosome pair" at lower side of cell. FIG. 11. Metaphase I in *P. alba* (diploid), with nineteen bivalent chromosomes. FIG. 12. Metaphase I in *P. alba* (triploid). Nine univalent, seven bivalent, ten trivalent, and one quadrivalent chromosomes are present. FIG. 13. Anaphase I in *P. laurifolia*, showing nineteen chromosomes at each pole. FIG. 14. Anaphase II in *P. alba* (diploid). FIG. 15. Anaphase I in *P. acuminata*. Two lagging univalent chromosomes are shown in division.

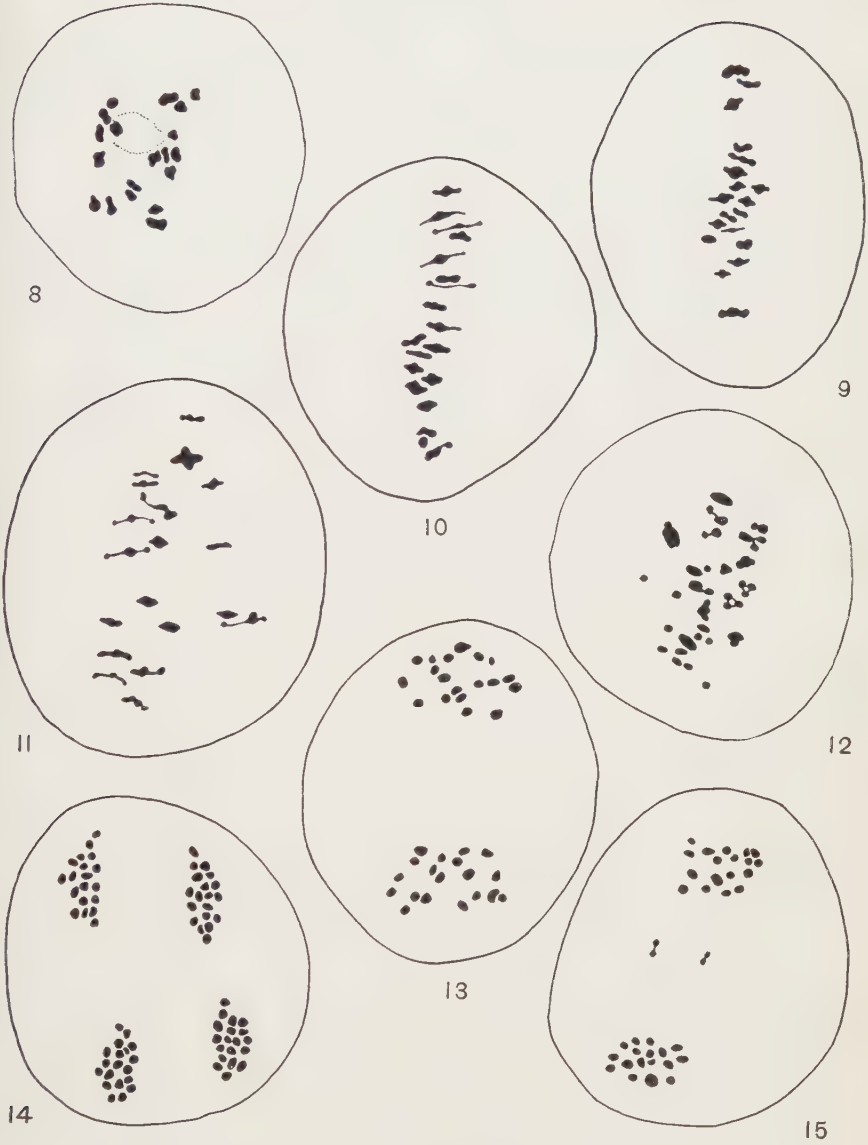
PLATE III

FIG. 16. Late diakinesis in the hybrid $\times P. Rasumowskyana \times P. caudina$, with nineteen bivalent chromosomes present. FIG. 17. Metaphase I in $\times P. Woobstii$ showing thirty-eight univalent chromosomes. FIG. 18. Metaphase I in *P. nigra* \times *P. laurifolia*, showing fourteen bivalent chromosomes on the plate and ten univalent chromosomes scattered at the sides. FIG. 19. Metaphase I in *P. nigra* \times *P. laurifolia*, showing nineteen bivalent chromosomes on the plate. FIG. 20. Regular anaphase in *P. nigra* \times *P. laurifolia*, with nineteen chromosomes at each pole. FIG. 21. Irregular anaphase I in *P. nigra* \times *P. laurifolia*; thirteen univalent chromosomes dividing on the plate; irregular distribution of chromosomes to the poles. FIG. 22. A third division within the pollen mother cell in $\times P. charkoviensis \times P. deltoides$, with a random distribution of the chromosomes to the poles. FIG. 23. Anaphase II in $\times P. Rasumowskyana \times P. caudina$. Apparently two lagging chromosomes have been lost at the first division and one is lagging at the second division.



CYTOLOGY AND SPECIATION IN POPULUS





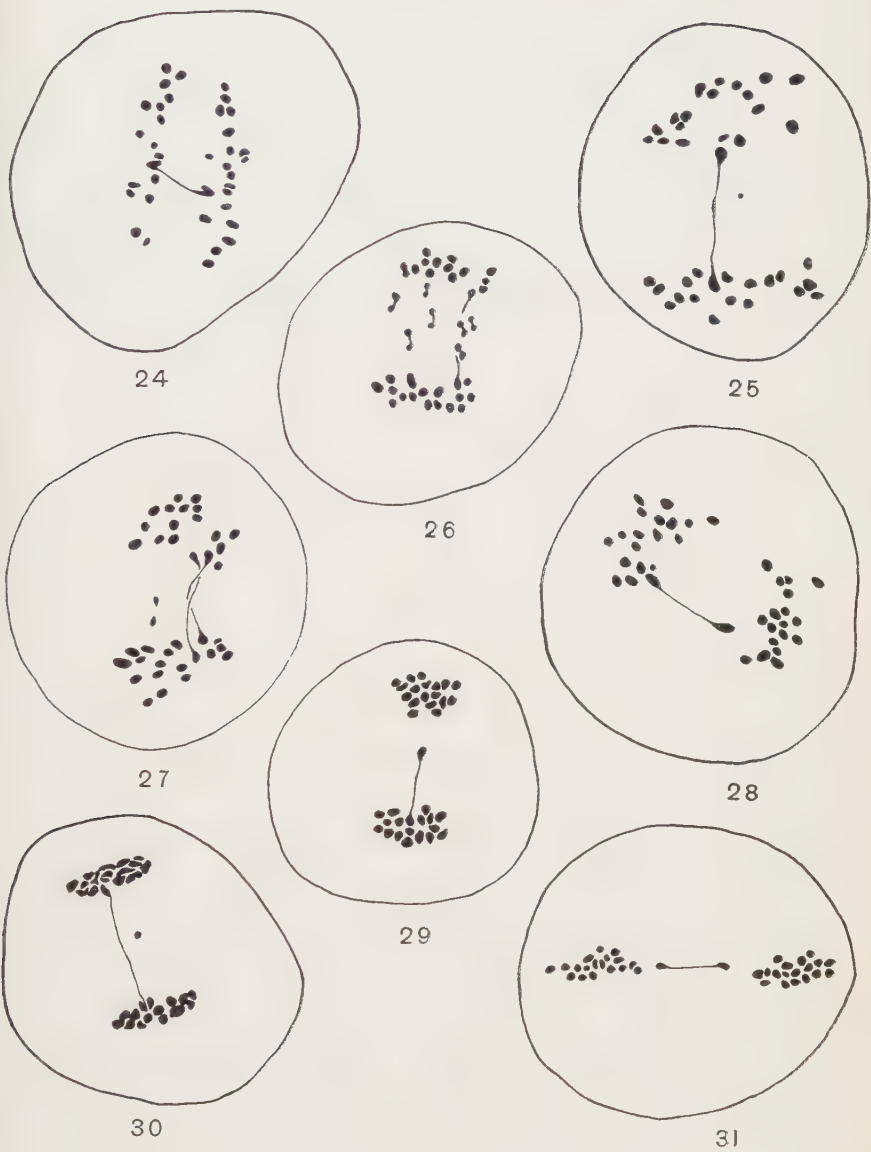
CYTOLOGY AND SPECIATION IN POPULUS





CYTOLOGY AND SPECIATION IN POPULUS





CYTOLOGY AND SPECIATION IN POPULUS

PLATE IV

FIG. 24. Early anaphase I in $\times P. charkoviensis \times \times P. berolinensis$, showing an inversion bridge without a visible fragment. FIG. 25. Anaphase I in $\times P. charkoviensis \times \times P. berolinensis$, with an inversion bridge and fragment. FIG. 26. Anaphase I in $\times P. charkoviensis \times \times P. robusta$. Remnant of an inversion bridge. FIG. 27. Anaphase I in $\times P. Rasumowskyana \times P. caudina$, showing two inversion bridges and one dividing fragment. FIG. 28. Anaphase I in $\times P. Rasumowskyana \times$ unidentified cottonwood. Bridge, no fragment visible. FIG. 29. Anaphase I in $P. nigra \times P. laurifolia$. Inversion bridge, no fragment. FIG. 30. Late anaphase I in $\times P. charkoviensis \times \times P. berolinensis$. Bridge and fragment. FIG. 31. Unbroken inversion bridge left out in cytoplasm at the first meiotic division in $\times P. Andrewsii$.

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PLANTS OF COAHUILA, EASTERN CHIHUAHUA, AND ADJOINING ZACATECAS AND DURANGO, I

IVAN M. JOHNSTON

IN this, the first of a projected series of papers, I begin an enumeration and analysis of the vascular flora found on the great arid plateau lying between the Eastern and Western Sierra Madre of northern Mexico. Predominantly a region of Cretaceous calcareous rocks, it contains many broad silty valleys, most of them bolsons, with extensive areas of desert scrub dominated by *Larrea* and *Flourensia*, and many scattered limestone mountain ranges, some of which support oak-chaparral on the higher ridges and in their upper canyons, and a few of which are lofty enough for the development of small coniferous forests. Igneous rocks, scattered and local in the eastern half of the plateau, increase in abundance and frequency toward the base of the predominantly igneous Western Sierra Madre and prevail in large areas in eastern Chihuahua, where grasslands and grassy hills with liveoaks are the characteristic types of vegetation.

The western limit of the region studied extends, roughly, from the area about Lake Guzman, in northwestern Chihuahua, southeast to near Chihuahua City and then southward in an irregular line west of Camargo and Jimenez to include the northern and eastern parts of the State of Chihuahua. Continuing southward, the limit passes west of Mapimi and Torreon to include the northeastern portions of the State of Durango. As the eastern limits of the area, I have followed the eastern boundary of the State of Coahuila. This includes parts of extreme eastern and northeastern Coahuila which are not parts of the plateau. Since, however, the few collections available from these districts represent a flora which, in large part, has extended up onto the plateau in the east-central parts of Coahuila, it has seemed practical and interesting to include in the catalogue, at least, records of all the collections available from the entire State of Coahuila.

The southern boundary is indefinite; in practice it roughly follows the latitude of the southeastern portion of the State of Coahuila. This includes in our area the northern portions of the State of Zacatecas. The northern limit follows the international boundary. Although the eastern and western limits of the areas studied are roughly natural, the northern and southern limits are not so. The plateau flora treated continues northward from our area into southern New Mexico and into trans-Pecos Texas, with many of its characteristic species reaching southeastern Arizona and the Edwards Plateau and its escarpments in Texas. The Rio Grande is not a floristic boundary. Floristically the Big Bend area of Texas and the mountains along the Rio Grande to the northwest of it have the closest of relations with the area south of the river. Because of the paucity of col-

lections made about our southern limits, little can be said regarding the details of species-distribution in that region. It is clear, however, that a great many species of our area extend south into the extensive desert tracts of northern San Luis Potosi. A goodly number reach their southern limits in the dry valleys of northwestern Hidalgo and some even on the arid plateau of central Mexico, in western Vera Cruz and adjacent Hidalgo and Puebla.

In publishing the present enumeration of species I am under no illusion that it approaches a nearly complete listing of all the species actually growing in the area. I shall, in fact, be surprised if it includes seventy-five percent of the total vascular flora. However, it will be vastly more complete and very much more detailed than Watson's enumeration of Edward Palmer's collections, *Proc. Am. Acad.* **17**: 316-361 (1882) and **18**: 96-191 (1883), published sixty years ago, the only listing of the flora to date. The present catalogue is based almost exclusively upon collections available at the Arnold Arboretum and the Gray Herbarium, particularly the latter. These include such classical collections as those of Berlandier, Gregg, Palmer, Pringle, and Purpus, and the less widely distributed recent collections from the area by L. H. Harvey, Harde LeSueur, E. G. Marsh Jr., C. H. Muller, Forrest Shreve, Stephen S. White, F. L. Wynd, F. L. Wynd & C. H. Mueller, and L. R. Stanford, K. L. Retherford & R. D. Northcraft. Reported upon also are the extensive collections made since 1941 by Mr. Robert Stewart in Coahuila and Chihuahua and those made in Coahuila and Chihuahua by Dr. C. H. Muller and me in 1940, and by me alone in 1941. Collections available from the area probably total well over 15,000 specimens. They do not represent, however, a satisfactory sampling of the flora of the whole area. There are available few if any collections from the Laguna District, the valleys of the Rio Florida, Rio Conchos, and Rio Grande, or from that very promising but unexplored large tract of desert country west of Ojinaga and east of the El Paso-Chihuahua City highway. The majority of the species missing from this catalogue will be discovered in these districts. It is recognized that the present catalogue can be only an incomplete preliminary one. I believe, however, that it will be adequate as a basis for a general discussion of the composition and origins of the flora. These general subjects, as well as matters regarding the geography and geology of the terrain, floristic areas, major plant-associations, collectors' itineraries, etc. will be covered in the concluding numbers of this series of papers.

My work on the flora of the intermontane plateau of northern Mexico has been carried on in close cooperation with Dr. Forrest Shreve, of the Desert Laboratory of the Carnegie Institution. One of the objectives of the present catalogue is to supply taxonomic and phytogeographical data for the detailed ecological survey of the intermontane plateau deserts of northern Mexico and adjacent United States being prepared by Dr. Shreve. In furtherance of the work I have had three seasons of field work in the area, in 1938, 1940, and 1941, financed by the Carnegie Institution and the Arnold Arboretum and by a grant from the William F. Milton Fund.

POLYPODIACEAE

by C. A. WEATHERBY

Woodsia mexicana Fée, Mém. Fam. Foug. **7**: 66. t. 26, f. 3 (1857).

COAHUILA: Sierra del Pino, crevices of limestone cliffs just below crest of high ridge west of La Noria, *Johnston & Muller* 612; Sierra Cruces, Cañon Tinaja Blanca, shaded cliff of igneous rock, open canyon, *Johnston & Muller* 284. CHIHUAHUA: Sierra Rica, Cañon Madera, scarce in shady rock-crevices in canyon, *Stewart* 2462. ZACATECAS: Concepcion del Oro, in earth in shade of rocks and bushes in elevated canyon, Aug. 1904, *Palmer* 257.

Western Texas to Arizona and south to San Luis Potosi and Vera Cruz. The two Coahuilan collections have the fronds glandular-pubescent beneath. They belong, accordingly, to the phase of the species described as *W. pusilla* Fourn. Bull. Soc. Bot. France **27**: 329 (1880), which outside our area has been collected in San Luis Potosi and in southern Arizona. In its glandularity this phase suggests *W. Plummerae*. It has, however, the deeply lacinate indusia characteristic of *W. mexicana*.

Woodsia Plummerae Lemmon, Bot. Gaz. **7**: 6 (1882).

CHIHUAHUA: Wet ledges in the hills northwest of Chihuahua, *Pringle* 455 and 834.

Ranging from trans-Pecos Texas (Davis Mts.) to Arizona and south into northern Mexico.

Cystopteris fragilis (L.) Bernh. in Schrad. Neu Jour. Bot. **12**: 26. t. 2, f. 9 (1806).

COAHUILA: Sierra del Carmen, Cañon Sentenela, *Wynd & Mueller* 521.

The collection cited is young and poorly developed, but it appears to belong with the Arizona phase of this cosmopolitan species described as subsp. *tenuifolia* Clute.

Dryopteris augescens (Link) C. Chr. var. **Lindheimeri** (C. Chr.) Broun, Ind. N. Am. Ferns 62 (1938).

D. normalis C. Chr. var. *Lindheimeri* C. Chr. Dansk. Vidensk. Selsk. Skr. Naturv. Afd. **10**: 182 (1913).

COAHUILA: Sierra Hechiceros, Cañon Indio Felipe, along creek in shady canyon, becoming 16 dm. tall, *Stewart* 73 and 113, *Johnston & Muller* 1376; Cañon del Agua Grande west of Las Delicias, by water, scarce, becoming 1 m. tall, *Stewart* 2797; El Tordillo, western margin of Valle de Delicias, frequent in shade near water, *Stewart* 2870.

The largest and most luxuriant fern in our area. It is known from southern Texas (as far east as Houston), Coahuila, Tamaulipas, and San Luis Potosi.

Phanerophlebia umbonata Underw. Bull. Torr. Bot. Cl. **26**: 211 (1899).

COAHUILA: Rancho Agua Dulce, wooded canyon on east slope of Sierra San Manuel, *Wynd & Mueller* 349; Sierra Gloria, *Marsh* 1871; Sierra Guajes, Cañon Milagro, shaded places in canyon, *Stewart* 1532 and 1533; Sierra Hechiceros, Cañon Indio Felipe, shade at base of cliffs in deep canyon, *Stewart* 523, *Johnston & Muller* 1362.

Mountains of Nuevo Leon, Tamaulipas, and Coahuila, and Chisos Mts., Texas.

Phanerophlebia auriculata Underw. Bull. Torr. Bot. Cl. **26**: 212 (1899).

COAHUILA: Sierra Mojada, Cañon Calabasa, fairly common in shade in deep canyon about 100 m. below crest, *Stewart* 2198. CHIHUAHUA: Canyon in Mapula Mts., southwest of Mapula Station, Oct. 1886, *Pringle* 831 (ISOTYPE).

Ranging from our area northward in western Chihuahua into Arizona and New Mexico.

Asplenium Palmeri Maxon, Contr. U. S. Nat. Herb. **13**: 39 (1909).

COAHUILA: Mountains 6 mi. east of Saltillo, 1880, *Palmer 1435*; San Antonio de los Alamos, under rocks in shaded gulch at base of high north-facing tuff cliffs, fronds prostrate, rooting at tip, *Johnston 8272*. CHIHUAHUA: Canyons in hills northwest of Chihuahua, Oct. 23, 1885, *Pringle 444*.

Ranging from central Texas to Arizona and south to Central America.

Asplenium resiliens Kunze, Linnaea **18**: 331 (1844).

COAHUILA: Rancho Agua Dulce, Sierra San Manuel, *Wynd & Mueller 351*; Sierra Gloria, *Marsh 1927*; mountains 6 mi. east of Saltillo, 1880, *Palmer 1435*; hills near Saltillo, shaded clay bank in deep arroyo, 1898, *Palmer 365*; hill near Saltillo, base of shaded rocks near summit, Aug. 10, 1905, *Palmer 755*; slope of mountain 24 km. north-west of Fraile, *Stanford et al. 408*; Sierra Guajes, Cañon Milagro, cliff-faces, *Stewart 1715*; mesa 15 km. northwest of Buena Vista, shade of cliff, *Stewart 1443*; escarpment on west side of Potrero de la Mula, about rocks on steep slope under oaks, *Johnston 9220*; Sierra Madera, Cañon del Agua, rock-crevices in moist dense wooded canyon, *Muller 3250*; Sierra Hechiceros, Cañon Indio Felipe, under rocks on bottom of deep shaded canyon, *Johnston & Muller 1360*; Sierra del Pino, crevices of north-facing limestone cliffs just below crest of high ridge west of La Noria, frequent, *Johnston & Muller 613*; western extremity of Sierra Madera, deep narrow canyon 2 km. southeast of Puertecito, shade of rocks on canyon bottom, *Johnston 9316*; Sierra Mojada, Cañon Hidalgo, shade in canyon below crest, *Stewart 1061*; Sierra Negras, 9 km. south of Parras, *Stanford et al. 193*. CHIHUAHUA: Sierra Rica, Cañon Madera, rock-crevices in shaded canyon, *Stewart 2474*.

Ranging from Pennsylvania, Kansas, and Arizona south along the Andean chain to Argentina (including *A. Lealii* Alston).

Asplenium exiguum Bedd. Ferns So. India *t. 146* (1863).

COAHUILA: Sierra Madera, Cañon del Agua, sparse in rock-crevices in moist densely wooded canyon, *Muller 3251*. CHIHUAHUA: Deep shaded damp glen at head of canyon next south of the large central canyon in the Mapula Mts., southwest of Mapula station, Nov. 4, 1886, *Pringle 833*.

A rare fern known only from scattered stations in Arizona, Sonora, Chihuahua, Coahuila, and Federal District, and from southern India and northern China.

Gymnopteris hispida (Mett.) Underw. Our Native Ferns ed. 6. 84 (1900).

Gymnogramma hispida Mett. ex Kuhn, Linnaea **36**: 72 (1869).

Bommeria hispida Underw. Bull. Torr. Bot. Cl. **29**: 633 (1902).

COAHUILA: Sierra Cruces, Cañon Tinaja Blanca, shelter of ledge in open canyon, *Johnston & Muller 281*. CHIHUAHUA: Sierra Rica, Cañon Madera, common in shaded places in canyon, *Stewart 2466*; Pirámide, base of rock-masses, *Johnston 8146*; 8 mi. northwest of Cruces, base of tuff cliff, *Johnston 7977*; Sierra Encinillas, 7 km. north of Fierro, among rocks on hillside, *Stewart 795*; near Chihuahua, *Pringle 465*.

This species ranges from western Texas to Arizona and south into Durango. In our area, at least, the species appears to be confined to areas of igneous rocks.

Pellaea cardiomorpha Weatherby, nom. nov.

Pteris cordata Cav. Descr. 267 (1802).

Pellaea cordata (Cav.) J. Sm. Cat. Kew Ferns 4 (1856), non Fée (1850-52).

COAHUILA: Sierra del Carmen, Cañon Sentenela, *Wynd & Mueller 590*. CHIHUAHUA: Sierra Rica, Cañon Madera, scarce in shady rock-crevices in canyon,

Stewart 2525; hills about 8 mi. northeast of Chihuahua, Oct. 17, 1885, *Pringle 448*. ZACATECAS: Pico de Teira, southwest of Cedros, Sept. 1908, *Lloyd 247* (US).

The new name for this species, *P. cardiomorpha*, is put forward with some diffidence. *Pellaea cordata* (Cav.) J. Sm. is definitely illegitimate, but, following Hooker, most authors have regarded *P. sagittata* (Cav.) Link as synonymous with it. If this be correct, the name *P. sagittata*, which is quite clear under *Pellaea*, should be taken up. But the material at hand indicates that the two species proposed by Cavanilles really differ in several characters, most of which, as Hooker long ago pointed out in regard to some of them, are not as constant as one could wish, but which, taken together, seem to give adequate grounds for separation. I have accordingly preferred to coin a new name in place of *P. cordata*, which has no indubitable synonym. The two species may be distinguished as follows:

Rhizome-scales bright brown in mass (contrasting with those of bud and stipe), linear or linear-lanceolate, sparsely pectinate with long, often retrorse teeth; blades not dimorphic, rachis and rachillae always glabrous, pinnules very broadly cordate, usually as broad as long, the margins usually not strongly revolute; spores globose or obtusely triangular in outline, especially so as seen from the commissural face, averaging about 50 μ in diameter.....*Pellaea cardiomorpha*.

Rhizome-scales pale brown, not contrasting with those of bud and stipe, mostly rather broadly lanceolate and serrulate with short teeth; fronds somewhat dimorphic, the sterile smaller and with broad plane pinnules, rachis and rachillae often with short and thick glandular hairs on upper surface, pinnules of the fertile fronds from deltoid-ovate to deltoid-lanceolate, the margins often strongly revolute; spores globose or the larger broadly ellipsoid, varying considerably in size, 65-80 μ , commonly about 75 μ*Pellaea sagittata*.

In addition to the above enumerated characters, the pinnae of *P. cardiomorpha* tend to stand at a broad angle to the rachis, those of the fertile fronds of *P. sagittata* to be more or less strongly ascending. In both, the lower leaf-surface may be either glabrous or pubescent with white hairs. In mature and well developed material the spore-characters hold consistently.

As here defined, *P. cardiomorpha* becomes a species mainly of northern and central Mexico, extending north to the Davis Mts., Texas, and south in eastern Mexico to Hidalgo, Michoacan, and Oaxaca. *Pellaea sagittata* ranges from San Luis Potosi and Zacatecas south to Guatemala and southward along the Andes to Bolivia.

***Pellaea intermedia* Mett. ex Kuhn, Linnaea 36: 84 (1869).**

COAHUILA: Sierra del Pino, Cañon Ybarra, arroyo banks, *Stewart 1821*; Sierra del Pino, La Noria, crevices in limestone along narrow shaded arroyo, *Johnston & Muller 642*; Picacho de San José, crevices of cliffs, *Stewart 1115*; San Antonio de los Alamos, about shaded tuff cliffs, *Johnston & Muller 859* and *900*; Lerios, 1880, *Palmer 1426*; Carneros Pass area, 1880, *Palmer 1427*; 4 km. east of Fraile, *Stanford et al. 354*; Sierra Negras, 9 km. south of Parras, *Stanford et al. 161*. CHIHUAHUA: Sierra Santa Eulalia, limestone ledges, *Pringle 461*. ZACATECAS: Mountain 18 km. west of Concepcion del Oro, *Stanford et al. 576*; Cedros, ravines, *Lloyd & Kirkwood 135*.

Ranging from trans-Pecos Texas to Arizona and south into our area and eastward into the mountains of Nuevo Leon. The type of *P. intermedia* is the rare glabrous phase of the species. Our plants belong to the common forma *pubescens* (Mett. ex Kuhn) Broun.

Pellaea ovata (Desv.) Weatherby, Contr. Gray Herb. **114**: 34 (1936).

Pellaea flexuosa (Kaulf. ex C. & S.) Link, Fil. Sp. 60 (1841).

COAHUILA: Sierra San Manuel, Rancho Agua Dulce, Wynd & Mueller 318; western base of Sierra Guajes 8 km. east of Buena Vista, igneous hillside, not common, Stewart 1467.

From central and southern Texas south through eastern Coahuila and the eastern Sierra Madre to Central and South America.

Pellaea atropurpurea (L.) Link, Fil. Sp. 59 (1841).

COAHUILA: Sierra San Manuel, Rancho Agua Dulce, Wynd & Mueller 358; western base of Sierra del Carmen 8 km. east of Hac. Encantada, shade in canyon, Stewart 1698; Sierra Guajes, Cañon Milagro, hillside, Stewart 1725; Sierra Madera, Cañon Charretera, stream-gravel in oak thicket, Johnston 9040; Sierra Gloria, Marsh 1888; Sierra Hechiceros, Cañon Indio Felipe, foot of talus slope, Stewart 171 and 172; Sierra del Pino, Cañon Ybarra, shade in canyon, Stewart 1813; Sierra del Pino, La Noria, shaded bushy arroyo-bank, Johnston & Muller 476; Picacho de San José, cliff-crevices, Stewart 1111; Sierra Mojada, Cañon Hidalgo, in shaded canyon below crest, Stewart 1065. CHIHUAHUA: Sierra Rica, Cañon Madera, rock-crevices in shaded canyon, Stewart 2475.

Ranging from Vermont and western South Dakota south to Guatemala.

Pellaea Wrightiana Hook. Sp. Fil. **2**: 142 (1858).

COAHUILA: Sierra Hechiceros, Rancho El Tule, about rocks on sunny hillside, Johnston & Muller 1309. CHIHUAHUA: Sierra Virulento, one plant on steep rocky east slope 3 mi. east of Rancho Virulento, Johnston 8090.

Ranging from central Texas to Baja California. Apparently a plant of igneous rocks.

Pellaea ternifolia (Cav.) Link, Fil. Sp. 59 (1841).

CHIHUAHUA: Grassy summits of the Sierra Santa Eulalia, southeast of Santa Eulalia, Nov. 5, 1885, Pringle 446; cool rocky slopes of mountains near Chihuahua, Oct. 1886, Pringle 920.

From southeastern Arizona south along the western Sierra Madre, extending to Peru, Argentina, and northern Chile. Apparently a plant of igneous rocks.

Pellaea microphylla Mett. ex Kuhn, Linnaea **36**: 86 (1869).

COAHUILA: Sierra San Manuel, Rancho Agua Dulce, Wynd & Mueller 320; Hill-coat Mesa, west of Encantada Ranch, Marsh 1454; high mesa 14 km. northwest of Buena Vista, common on open hillside, Stewart 1435; Sierra Madera, Cañon Charretera, rocky bed of arroyo, abundant, Johnston 8930; Sierra Gavia, under rocks on canyon floor, Johnston 7206; Puerto San Lazaro, scattered on open talus slope, Muller 3079; mountains 6 mi. east of Saltillo, 1880, Palmer 1423; San Lorenzo Canyon, 6 mi. southeast of Saltillo, rather common in rather exposed parts of canyon, Sept. 1904, Palmer 404; Lerios, July 1880, Palmer 1424; mountain 24 km. northwest of Fraile, Stanford et al. 416; Sierra del Pino, Cañon Ybarra, rocky hillside, common, Stewart 1884; Sierra del Pino, summit of great western escarpment about 10 mi. north of La Noria, under rocks, Johnston & Muller 552; Sierra del Pino, crest of eastern ridge about 4 mi. northeast of La Noria, under rocks, Johnston & Muller 654; western base of Picacho del Fuste, limestone ledges on north slope, Johnston 8389; top of Cuesta Zozaya, about rocks on dry open slope, Johnston 9291; western extremity of Sierra Madera, deep narrow canyon 2 mi. southeast of Puertecito, among rocks of canyon-floor and in rock-crevices on canyon-walls, Johnston 9318; Santa Elena, eastern foothills of Sierra Cruces, ledges and rocky slopes, Johnston & Muller 207, Stewart 271 and 346; Sierra Mojada, Cañon Hidalgo, shade in canyon below crest, Stewart 1066; east side of Valle Acatita, crevices in limestone 2 km. northeast of Parritas, Stewart 2767; margin of

Valle Delicias, 1 km. northwest of mouth of Cañon Blanco, frequent in arroyos, *Stewart 2912*. CHIHUAHUA: Sierra San Carlos, base of cliff near mouth of canyon, *Johnston & Muller 44*; Sierra Almagre, dry sunny floor of arroyos, *Johnston & Muller 1136*; high northwestern end of Sierra Diablo, rocky hillside, *Stewart 986*; Sierra Santa Eulalia, limestone hillside, *Pringle 440* and *458*; pass 19 mi. east of Jimenez, limestone hillside, *Johnston 7854*. ZACATECAS: valley 15 km. west of Concepcion del Oro, *Stanford et al. 47*.

Centering in our area and extending eastward into the Sierra Madre of Nuevo Leon, and northward to the south escarpment of the Edwards Plateau and trans-Pecos Texas. Confined to limestone.

Notholaena delicatula Maxon & Weatherby, Contr. Gray Herb. **127**: 7 (1939).

COAHUILA: Sierra Madera, Charretera Cañon, steep north slope in conifer forest, on rocks, about 8500 ft. alt., *Johnston 9046*; Leries, July 1880, *Palmer 1387* (TYPE); Carneros Pass area, March 1880, *Palmer 1385*.

Endemic to the mountains of southeastern Coahuila and northern Nuevo Leon. The record from Jalisco, Maxon & Weatherby, l. c., was caused by an error on one of Pringle's labels. Though indicated to be from Jalisco, the collection actually came from near Monterey, Nuevo Leon.

Notholaena limitanea Maxon, var. *mexicana* (Maxon) Broun, Ind. No. Am. Ferns **119** (1938).

Notholaena limitanea subsp. *mexicana* Maxon, Amer. Fern Jour. **9**: 72 (1919).

COAHUILA: Sierra Madera, Cañon Charretera, on rocks on steep north slope in coniferous forests, about 8500 ft. alt., *Johnston 9046a*; base of mountains southeast of Saltillo, road to Diamante Pass, limestone ledge, *Johnston 7269*; Carneros Pass, *Pringle 3031* (Field Mus.); Sierra del Pino, high western ridge 10 mi. north of La Noria, under limestone rocks along ridge-crest, *Johnston & Muller 551*; Sierras Negras, 9 km. south of Parras, *Stanford et al. 201* in pt.; Picacho de Jimulco, summit, *Stanford et al. 107*. CHIHUAHUA: Sierra Santa Eulalia, limestone ledges, Sept. 13, 1885, *Pringle 451* (ISOTYPE). ZACATECAS: mountain 18 km. west of Concepcion del Oro, *Stanford et al. 574*; Cedros, canyons, *Kirkwood 140*.

Ranging from our area into Durango and possibly Tamaulipas. Among the cited collections, *Johnston 7269* is exceptionally stout and strict for this variety. It is, however, approached by some individuals of the type collection, and in all technical details, especially the strongly reticulate-rugose spores, it entirely agrees with them.

Notholaena aurea (Poir.) Desv. Mém. Soc. Linn. Paris **6**: 219 (1827).

VERNACULAR NAMES: Canaguala; Canawala.

COAHUILA: Sierra del Carmen, Cañon Sentenela, Wynd & Mueller *511*; Mesa Grande, high mesa 40 km. northwest of Hac. Encantada, open hillside, not common, *Stewart 1644*; Soledad, Sept. 1880, *Palmer 1399*; Saltillo, purchased in market, Sept. 1898, *Palmer 369*; mountain borders near Saltillo, July 6, 1848, *Gregg 219*; Sierra Hechiceros, Cañon Indio Felipe, common at base of cliffs and on talus, *Stewart 89* and *135*; Sierra Hechiceros, Rancho El Tule, about rocks on arid hillside, *Johnston & Muller 1310*; San Antonio de los Alamos, local, shaded places under tuff cliffs, *Johnston & Muller 899*; Sierra Jimulco, 11 km. northeast of Jimulco, *Stanford et al. 84*. CHIHUAHUA: Sierra Rica, Cañon Madera, common on open sunny slopes, *Stewart 2467*; Pirámide, one colony at base of large rock-masses, *Johnston 8144*; Sierra Virulento, rocky east slope, *Johnston 8083*; 8 mi. northwest of Cruces, base of sandstone cliff, *Johnston 7980*; 11 mi. northeast of Camargo, lava cliff, *Johnston 7896*; rocky hills near Chihuahua, Oct. 1885, *Pringle 462*.

Ranging from Texas and Arizona south to Argentina. Palmer reports

that this fern is sold in the market at Saltillo, a decoction of the plant being taken internally for "pain in the stomach and for coughs."

Notholaena sinuata (Lag.) Kaulf. Enum. Fil. 135 (1824).

VERNACULAR NAMES: Nacahuela; Lengua de Cervo.

COAHUILA: Sierra del Carmen, Cañon Sentenela, Wynd & Mueller 510; Sierra Encantada, Cañon San Enrique, west of Buena Vista, bank of dry arroyo, Stewart 1407; Sierra Azul, Buena Vista Ranch, July 8, 1938, Marsh 1220; Saltillo, crevices of sandstone at summit of a mountain, 1898, Palmer 183; Lerios, 1880, Palmer 1400; 3 km. southwest of Fraile, in arroyo, Stanford et al. 336; Sierra del Pino, Cañon Ybarra, arroyo banks, Stewart 1821a; Sierra Madera, Cañon Charretera, moist ledges, Johnston 9097; Cañon de Jara, east of Socorro, Schroeder 10; Sierra Cruces, near Santa Elena, shady arroyo, Stewart 292; Picacho de San José, crevices of cliffs, Stewart 1110; Sierras Negras, 9 km. south of Parras, Stanford et al. 203; Picacho de Jimulco, summit, Stanford et al. 105. CHIHUAHUA: 11 miles northeast of Camargo, lava cliff, Johnston 7923. ZACATECAS: Cedros, canyons, Lloyd & Kirkwood 138 in pt.

South-central Texas to Arizona and southward in the Andean region to northern Argentina.

Notholaena sinuata var. **integerrima** Hook. Sp. Fil. 5: 108 (1864).

COAHUILA: Rancho Agua Dulce, Sierra San Manuel, Wynd & Mueller 321; Sierra Azul, Buena Vista Ranch, July 8, 1938, Marsh 1250; Soledad, 1880, Palmer 1402; Saltillo, 1880, Palmer 1401; Buena Vista, 1848, Gregg 297 in pt.; San Antonio de los Alanzanes, 1848, Gregg 365; Lerios, 1880, Palmer 1406; mountain valley 24 km. northwest of Fraile, Stanford et al. 429a; Sierra del Pino, Cañon Ybarra, arroyo banks, Stewart 1843; about 10 miles north of Cuatro Ciénegas, Wynd 745a; El Coyote, east side Valle Acatita, Stewart 2731 and 2751; Puerto Ventanillas, south of Las Delicias, on slopes, Stewart 2963; mouth of Cañon Blanco, north end of Valle Delicias, Stewart 2904; San Lorenzo de Laguna, 1880, Palmer 1409. CHIHUAHUA: Chihuahua, Pringle 464 in pt. ZACATECAS: Mountain 18 km. west of Concepcion del Oro, Stanford et al. 575; Cedros, canyons, Lloyd & Kirkwood 136 in pt. and 137.

Southern Oklahoma (Arbuckle Mts.) and central Texas to southeastern Arizona and southward, mostly along the eastern Sierra Madre, to Vera Cruz.

Hooker's name, *N. sinuata* var. *integerrima*, has very generally been applied to the plant here classified as *N. sinuata* var. *cochisensis*. That application can no longer be maintained. When he proposed var. *integerrima*, Hooker cited three collections in the Kew Herbarium, of Liebmann, Gregg [297] and Seemann [1928]. Of these, only the Liebmann specimen is labelled as belonging to the variety. It is a single small frond with oblong, quite entire pinnae, the scales of the lower surface like those of typical *N. sinuata*, but those of the upper relatively broad-bladed and persistent as in var. *cochisensis*. The Seemann material is similar, though much more ample, the sheet containing four complete individuals. The pinnae are small, the smallest approaching the dimensions of var. *cochisensis*, and there is also some approach to that variety in the scales of the lower surface. The Gregg collection, as represented in Hooker's herbarium, consists of a detached frond similar to the Liebmann specimen and an entire plant of var. *cochisensis*. Had Hooker cited this last Gregg specimen particularly or accounted for it in his description, it might have been designated as type and the usual application of his name maintained.

But one can hardly reconcile his statement "pinnae entire or nearly so" with var. *cochisensis*, in which the pinnae, though tiny, show at least one conspicuous lobe. In view of this and of Hooker's having labelled only the Liebmann specimen, it must be taken as type and the epithet *integerrima* applied accordingly.

Field observation and a restudy of material in the Gray Herbarium indicate that rather numerous specimens with shallowly lobed pinnae, which have hitherto either been associated with var. *cochisensis* or regarded as dwarfed individuals of typical *N. sinuata*, actually belong with var. *integerrima*, as represented by the Liebmann and Seemann collections. They are like these collections in their combination of scale-characters, in their small size, and, except for the lobing of the pinnae, in habit. They are accordingly here placed in var. *integerrima*. So understood, that group becomes a reasonably consistent, if not altogether happily named, variety, intermediate in characters between typical *N. sinuata* and var. *cochisensis*, grading into both, and with the mainly Texan and northeast-Mexican range above indicated.

In central Mexico, typical *N. sinuata* also produces a phase with entire pinnae (*N. laevis* of authors, not Mart. & Gal.; *N. crassifolia* Moore & Houlst.; *N. pruinosa* Fée).

Notholaena sinuata* var. *cochisensis (Goodding) Weatherby, comb. nov.

Notholaena cochisensis Goodding, *Muhlenbergia* 8: 93 (1912).

Notholaena sinuata var. *crenata* Lemmon, *Ferns Pacific Slope* 7 (1882), nomen nudum.

VERNACULAR NAMES: Canelilla; Doradillo.

COAHUILA: Between Rancho Santo Domingo and Hac. Piedra Blanca, *Wynd & Mueller* 659 (US); Sierra Azul, Buena Vista Ranch, July 8, 1938, *Marsh* 1239; Sierra San Vicente, Cañon Espantosa, *Schroeder* 61; 6 mi. north of Hipolito, *Johnston* 7235; mountains 6 mi. east of Saltillo, 1880, *Palmer* 1401; Buena Vista, 1848, *Gregg* 297 in pt.; Chojo Grande, 27 mi. southeast of Saltillo, 1904, *Palmer* 359; Lerios, 1880, *Palmer* 1405; Carneros Pass area, 1880, *Palmer* 1407 in pt.; 4 km. east of Fraile, *Stanford et al.* 355; Sierra del Pino, ridge-crest 4 mi. northeast of La Noria, *Johnston & Muller* 652; Sierra Madera, Cañon Charretera, ledges, *Johnston* 9096; 10 mi. north of Cuatro Cienegas, *Wynd* 745; Cañon de Jara, east of Socorro, *Schroeder* 16; Sierra Cruces, near Santa Elena, slopes, *Johnston & Muller* 235; Cañon del Agua Chica, west of Las Delicias, gypsum, *Stewart* 2827; near mouth of Cañon Blanco, Sierra Margaritas, limestone crevices, *Stewart* 2905; San Lorenzo de la Laguna, 1880, *Palmer* 1410; Sierras Negras, 9 km. south of Parras, *Stanford et al.* 194; Sierra Jimulco, 11 km. northeast of Jimulco, *Stanford et al.* 42. CHIHUAHUA: Sierra Rica, Dec. 1882, *Newberry*; Chihuahua, 1908, *Palmer* 357; pass 19 mi. east of Jimenez, limestone, *Johnston* 7853; 6 mi. west of Piloncillo, lava hillside, *Johnston* 7880a. DURANGO: 23 mi. north of Zaragoza, under sandstone rocks, *Johnston* 7792. ZACATECAS: Valley 15 km. west of Concepcion del Oro, *Stanford et al.* 548; Cedros, canyons, *Lloyd & Kirkwood* 138 in pt.

This is the plant which has long been called *N. sinuata* var. *integerrima*. The three recognizable variants of *N. sinuata* may be distinguished as follows:

Pinnae 1 cm. or more long, ovate, commonly subacute and cut $\frac{1}{3}$ – $\frac{1}{2}$ to the midrib into 4–6 pairs of oblong lobes; scales of the upper surface of the lamina with narrow central portion or reduced to stellate processes, usually soon deciduous, those of the

lower surface lanceolate, up to 1.5 mm. long; rhizome-scales pectinate-ciliate or -serrulate.....*N. sinuata* (typical).

Pinnæ mostly less than 1 cm. long, very obtuse, with 1-3 pairs of broadly ovate lobes or entire; scales of the upper surface with relatively broad central portion, usually persistent till full maturity of the frond.

Pinnæ oblong, entire or with about 3 pairs of shallow lobes; scales of lower surface and rhizome as in the typical variety.....var. *integerrima*.

Pinnæ subquadrate, nearly or quite as broad as long, with 1 or 2 (rarely 3) pairs of lobes; scales of the lower surface ovate, 0.5 mm. long; rhizome-scales entire or nearly so.....var. *cochisensis*.

A good many field observers are of the opinion that var. *cochisensis* should be treated as a distinct species, and their contention has been strengthened by the recent discovery that the variety is poisonous to stock, the typical form not. Nevertheless, judged by the usual taxonomic evidence, var. *cochisensis* is so connected with the typical variety, through var. *integerrima*, that the traditional treatment of it as a variety only is not unreasonably conservative.

Notholaena Aschenborniana Klotzsch, *Linnaea* **20**: 417 (1847).

COAHUILA: Sierra San Manuel, Wynd & Mueller 337 (US); Sierra Gavia, 5 mi. north of Saucillo, under rocks, terrace on canyon-floor, Johnston 7209; mountains 8 mi. west of Saltillo, hillside, Johnston 7660; San Lorenzo Canyon, 6 mi. southeast of Saltillo, sunny arroyo-banks at canyon-mouth, 1904, Palmer 402; Sierra del Pino, La Noria, crevices of limestone in narrow shaded arroyo, Johnston & Muller 643; western base of Picacho del Fuste, north-facing slope about limestone ledges, Johnston 8384; Sierra Madera, Cañon Charretera, ledges and rocky arroyo-bed, Johnston 8928, 8931a, 9094; gorge just east of Socorro, on cliffs, Johnston 8850a; Sierra Mojada, Jones 531 (US); western edge of Valle Acatita, 2 km. northeast of Parritas, shaded crevices in limestone, Stewart 2768; Cañon Blanco, Sierra Margaritas, shade of cliffs, Stewart 2915; Sierra Negras, 9 km. south of Parras, Stanford et al. 204. CHIHUAHUA: Sierra Santa Eulalia, limestone ledges, Pringle 466 and 469.

Western Texas to Arizona and south to central Mexico.

Notholaena Schaffneri (Fourn.) Underw. var. **Nealleyi** (Seaton) Weatherby, comb. nov.

Notholaena Nealleyi Seaton ex Coulter, Contr. U. S. Nat. Herb. **1**: 61 (1890).

COAHUILA: Mountains 4 mi. west of Cuatro Cienegas, shaded rock-crevices in small canyon, Johnston 7167; Sierra Cruces, sheltered on north-facing limestone ledges at Santa Elena, Johnston & Muller 205.

The type of *N. Nealleyi* came from Limpia Canyon, Jeff Davis Co., Texas (*Nealley* 560). These, at least, are the data accompanying the specimen designated as type in the U. S. Nat. Herb. The collector's number has been changed from 894 to 560. As published, the type was said to come from the Chinati Mts. and to be numbered 894. Other collections of this fern have been made at Goodenough Springs, Val Verde Co., Texas (*Nealley* 123), and from Barranco de Santa Maria, Zacuapan, Vera Cruz (*Purpus* 6199). They may be distinguished from typical *N. Schaffneri* as follows:

Rhizome-scales narrowly linear-attenuate, densely and conspicuously pectinate-ciliate; median pinnæ with 4-6 pairs of free pinnales.....*N. Schaffneri* (typical).

Rhizome scales linear-subulate, sparsely and inconspicuously pectinate-ciliate; median pinnæ usually with 1-3 pairs of free pinnales.....*N. Schaffneri* var. *Nealleyi*.

The Nealley and Purpus specimens, mentioned above, are small and

have passed as immature individuals. The two collections from Coahuila, however, have fronds up to 22 cm. long and freely soriferous, and are obviously full grown. The characters of the variety are retained even in this mature state. Davenport, Bot. Gaz. **16**: 54 (1891), observed that two plants were involved in this species-aggregate, but unfortunately he supposed Fournier's rather small type material to be the same as Nealley's specimens and gave a new name (*N. Schaffneri* var. *mexicana*) to the typical variety of *N. Schaffneri*.

Notholaena Grayi Davenp. Bull. Torr. Bot. Cl. **7**: 50 (1880).

COAHUILA: Soledad, Sept. 1880, *Palmer 1388*; San Antonio de los Alamos, under rocks, dry basalt in upper canyon, *Johnston & Muller 926*. CHIHUAHUA: Sierra Encinillas, rocky hillside 6 km. north of Fierro, common in crevices, igneous rocks, *Stewart 790*; cliffs of volcanic tuff, 8 mi. northwest of Cruces, *Johnston 7984*; 11 mi. northeast of Camargo, lava cliff, *Johnston 7902*; 6 mi. west of Piloncillo, lava hillside, *Johnston 7880*; rocky hills near Chihuahua, *Pringle 463* in pt.

Ranging from Texas and Arizona south through Chihuahua and Sonora to Jalisco.

Notholaena aliena Maxon, Contr. U. S. Nat. Herb. **17**: 605 (1916).

COAHUILA: Soledad, Sept. 1880, *Palmer 1389* (ISOTYPE). CHIHUAHUA: Rocky hills near Chihuahua, Oct. 1885, *Palmer 463* in pt.

Known from Tamaulipas, Coahuila, Chihuahua, and Arizona.

Notholaena candida (Mart. & Gal.) Hook. Sp. Fil. **5**: 110 (1864).

COAHUILA: Villa Juarez, Sept. 1880, *Palmer*; Muzquiz, *Marsh 351* (US); mountains northeast of Monclova, Sept. 1880, *Palmer 1380*; Sierra Gavia, 5 mi. north of Saucillo, under rocks on terrace in canyon, *Johnston 7205*; gorge just east of Socorro, on cliffs, *Johnston 8849*; western extremity of Sierra Madera, deep narrow canyon 2 km. northeast of Puertecito, ledges on canyon-wall, *Johnston 9319*.

Ranging from Texas and New Mexico south to Guatemala.

Notholaena neglecta Maxon, Contr. U. S. Nat. Herb. **17**: 602 (1916).

COAHUILA: San Lorenzo Canyon, 6 mi. southeast of Saltillo, a few plants in narrow seams in the rock near the ground, dry but somewhat shaded, 1904, *Palmer 424*; Saltillo, crevices on dry sloping side of canyon, 1902, *Palmer 324* (ISOTYPE); high western ridge of Sierra Fragua, north of Puerto Colorado, under rocks on pinyon-clad steep east-slope, scarce, *Johnston 8775*; western extremity of Sierra Madera, deep narrow canyon 2 km. southeast of Puertecito, ledges on canyon-wall, one colony, *Johnston 9319a*; Sierra Cruces, canyon 5 mi. southwest of Santa Elena, crevices of shales on shaded canyon-wall, local, *Johnston & Muller 822*; La Botica, Sierra Margaritas, limestone cliffs, scarce, *Stewart 2894*; Sierra Mojada, Apr. 19, 1892, *Jones 520* (US). CHIHUAHUA: Sierra Santa Eulalia, limestone cliffs, Sept. 9, 1885, *Pringle 452*.

Ranging from southeastern Arizona south into Chihuahua and into eastern Coahuila. The collection from the Sierra de la Fragua is an unusually narrow-bladed form with relatively small basal pinnae.

Notholaena Standleyi Maxon, Amer. Fern Jour. **5**: 1 (1915).

COAHUILA: Near Santo Domingo, igneous hill, *Wynd & Mueller 467*; Saltillo, summit of mountain, shaded crevices of sandstone, May 1898, *Palmer 184*; Saltillo, 1905, *Palmer 754*; Carricito, north-facing ledge of lava, *Johnston & Muller 163*; eastern foothills of Sierra Cruces, vicinity of Santa Elena, shaded rock-crevices, *Stewart 347*; Sierra Cruces, Cañon Tinaja Blanca, hillsides and along arroyo, *Stewart 330* and *624*, *Johnston & Muller 296*; base of tuff cliffs 3 mi. northwest of San Antonio

de los Alamos. *Johnston & Muller* 857; La Botica, base of Sierra Margaritas, limestone cliffs, *Stewart* 2893; canyon-mouth, Cañon Blanco, Sierra Margaritas, crevices on slope, *Stewart* 2907; canyon 6 mi. west of Viesca, *Johnston* 7744; Picacho de Jimulco, about summit, *Stanford et al.* 89; San Lorenzo de la Laguna, 1880, *Palmer* 1379. CHIHUAHUA: Sierra Rica, Dec. 1882, *Newberry*; Sierra San Carlos, road to mines, base of limestone cliff at canyon-mouth, *Johnston & Muller* 37; Sierra Encinillas, 7 mi. north of Fierro, among rocks on hillside, *Stewart* 794; 8 mi. northwest of Cruces, base of tuff cliff, *Johnston* 7979; hills west of Chihuahua, *Pringle* 467; Meoqui, *LeSueur* 1138; 11 mi. northeast of Camargo, lava cliff, *Johnston* 7895; Cañon La Renga, 15 km. northwest of Santa Fe, crevices of limestone, common, *Stewart* 2618.

Ranging from Texas and western Oklahoma to Nevada and Arizona and south through western Mexico to central Mexico.

Notholaena Greggii (Mett. ex Kuhn) Maxon, Contr. U. S. Nat. Herb. **17**: 606 (1916).

Pellaea Greggii Mett. ex Kuhn, *Linnaea* **36**: 86 (1869).

Allosorus Greggii (Mett. ex Kuhn) Kuntze, Rev. Gen. **2**: 806 (1891).

Notholaena Pringlei Davenp. Bull. Torr. Bot. Cl. **13**: 132. t. 58 (1886).

Cheilanthes Davenportii Domin, Bibl. Bot. **20**[Heft 85]: 133 (1915).

COAHUILA: Monclova, Aug. 1880, *Palmer* 1383; 10 mi. north of Cuatro Ciénegas, Wynd 747; Lomas del Aparejo, eastern side of Llano de Guaje, dry limestone ledges on sunny hillside, *Johnston & Muller* 774; Tanque La Luz, south end of Cañada Oscuro, limestone ledges between gypsum on escarpment, *Johnston* 8503; Sierra Cruces, limestone ledges near Santa Elena, *Johnston & Muller* 206; south base of Picacho de San José, in arroyo, confined to gypsum, *Johnston & Muller* 817; San José, under basaltic rocks on rocky hillside, *Johnston & Muller* 994; Sierra Planchada, 6 mi. northeast of Esmeralda, limestone ledges on hillside, *Johnston & Muller* 833; Sierra Mojada, *Jones* 519 (US); Cerro Zapatero, July 1910, *Purpus* 4633; El Coyote, eastern margin of Valle Acatita, crevices on slope, *Stewart* 2743; Rancho Las Uvas, east side Valle Acatita, gypsum, *Stewart* 2693; Cañon del Agua Chica, west of Las Delicias, shade on gypsum cliffs, *Stewart* 2831; mouth of Cañon Blanco, Sierra Margaritas, limestone crevices, *Stewart* 2906; San Lorenzo de la Laguna, May 1880, *Palmer* 1382 and 1383. CHIHUAHUA: Sierra Rica, Dec. 1882, *Newberry*; Sierra Santa Eulalia, dry calcareous ledges and bluffs, April 23, 1885, *Pringle* 441 (type of *N. Pringlei*); Sierra Santa Eulalia, calcareous bluffs. Nov. 15, 1888, *Pringle* 857; Cañon del Coyote, 20 km. northwest of Santa Fe, crevices of limestone, common, *Stewart* 2614. DURANGO: Rocky hill northwest of Mapimi, April 17, 1847, *Gregg* 467 (isotype of *N. Greggii*); Lerdo, Cerro el Raymundo, *Chaffey* 58 in pt. (US); 7 mi. southwest of Chocolate, shaded slope, *Shreve* 9113.

This species is practically confined to our area. Outside, it has been found on the northern side of the Rio Grande at the mouth of Boquillas Canyon in Texas. While evidently not confined to it, the species is frequently found on or near gypsum. The type of *Notholaena Greggii*, judging from the date on the type-specimen, was collected near the Durango-Chihuahua state-line northwest of Mapimi, between Jaralito and Arroyo de Cerro Gordo.

Notholaena bryopoda Maxon, Proc. Biol. Soc. Wash. **18**: 205 (1905).

COAHUILA: Western base of Picacho del Fuste, north-facing mountain-side, common on all gypsum beds and confined to them, *Johnston* 8354; south end of Cañada Oscuro near Tanque La Luz, common on the gypsum beds on the escarpment, confined to gypsum, *Johnston* 8488; eastern foothills of Sierra Cruces near Santa Elena, forming large clumps on gypsum beds, confined to gypsum, *Stewart* 839, *Johnston & Muller* 243; Rancho del Coyote, eastern margin of Valle Acatita, crevices on gypsum, common, *Stewart* 2732.

Outside of our area this fern is known only from the type-collection, made by Pringle in the mountains of southern Nuevo Leon, 15-20 miles south of Doctor Arroyo. The plant appears to be a marked gypsophile. In the Sierra Cruces, near El Fuste, and in Cañada Oscuro, the plant was abundant and luxuriating on gypsum and confined to that substratum. It forms dense clumps which may become as much as a meter in diameter.

Cheilanthes alabamensis (Buckl.) Kunze, *Linnaea* **20**: 4 (1847).

COAHUILA: Rancho Agua Dulce, wooded canyon on east slope of Sierra San Manuel, Wynd & Mueller 377; ravine near Puerto Santa Anna, Hac. Mariposa, Wynd & Mueller 219; Sierra Guajes, Cañon Milagro, faces of cliffs, Stewart 1714; Caracol Mts., 1880, Palmer 1419; Soledad, Sept. 1880, Palmer 1420; Saltillo, shaded clay bank in deep arroyo, 1898, Palmer 366 in pt.; Saltillo, Sierra del Pueblo, moist rock crevices near ground, 1904, Palmer 433 in pt.; San Lorenzo Canyon, 6 mi. southeast of Saltillo, Sept. 1904, Palmer 405 in pt.; San Lorenzo Canyon, shaded rocky canyon wall, Sept. 1904, Palmer 403; Cañon del Chojo Grande, 27 mi. southeast of Saltillo, earth at base of shady rock, Aug. 1904, Palmer 377; General Cepeda, high bluff, 1904, Palmer 326 in pt.; Sierra del Pino, La Noria, shaded arroyo banks, Johnston & Muller 495 and 644; western extremity of Sierra Madera, deep narrow canyon 2 km. southeast of Puertecito, under rocks on shaded canyon-floor, Johnston 9314; Sierra Parras, March 1905, Purpus 1100; Sierra Hechiceros, Cañon Indio Felipe, under rocks in deep shaded canyon, Johnston 1361; Sierra Cruces, Cañon Tinaja Blanca, shrubby banks and shaded cliffs, Stewart 331, Johnston & Muller 282; San Antonio de los Alamos, moist shaded places about tuff cliffs, Johnston & Muller 894. CHIHUAHUA: Sierra Almagre, about rocks in deep shaded canyon, Johnston & Muller 1193; Sierra Santa Eulalia, shaded places, Nov. 2, 1885, Pringle 449.

This fern ranges from Virginia to Florida, west to Missouri and Arizona, and south into Nuevo Leon, Coahuila, and Chihuahua.

Cheilanthes notholaenoides (Desv.) Maxon ex Weatherby, Contr. Gray Herb. **114**: 34 (1936).

VERNACULAR NAME: Sanguinaria.

COAHUILA: Saltillo, shaded clay bank in deep arroyo, 1898, Palmer 366 in pt.; Saltillo, under rock ledge on exposed hillside, June 1898, Palmer 238; Saltillo, purchased in market under name "Sanguinaria," Sept. 1898, Palmer 368; mountains 6 mi. east of Saltillo, 1880, Palmer 1418; base of mountains southeast of Saltillo, road to Diamante Pass, Johnston 7268; San Lorenzo Canyon, 6 mi. southeast of Saltillo, Sept. 1904, Palmer 405 in pt.; Carneros Pass area, March 1880, Palmer 1417; mountains 24 km. northwest of Fraile, in arroyo, Stanford et al. 385; Sierra Madera, Cañon Charretera, in shade on rocky bed of arroyo, Johnston 8929; Sierra Mojada, Cañon Hidalgo, shade in canyon below crest, common, Stewart 1067; Sierra Negras, 9 km. south of Parras, Stanford et al. 209. CHIHUAHUA: Sierra Almagre, under rocks on shaded canyon-floor, Johnston & Muller 1152; Sierra Santa Eulalia, shaded places, Nov. 2, 1885, Pringle 449. ZACATECAS: Mountain 18 km. west of Concepcion del Oro, Stanford et al. 573; Cedros, Lloyd 125.

Entering our area from the south and southeast, extending north from Guatemala through eastern Mexico and reaching its northern limit in Coahuila and Chihuahua, where it grows with the related *C. alabamensis* and, at times, is separated with difficulty from that more northerly ranging species. Palmer reports that small bunches of this fern are sold in the market at Saltillo under the name "Sanguinaria," a decoction of the plant being drunk "to purify the blood."

Cheilanthes aemula Maxon, Contr. U. S. Nat. Herb. **10**: 495 (1908).

COAHUILA: Sierra Guajes, Cañon Milagro, on cliffs, not common, Stewart 1710;

Mt. Caracol, 1880, *Palmer 1412*; Sierra Hechiceros, Cañon Indio Felipe, base of talus-slope, not common, *Stewart 155*.

Ranging from Texas (escarpment of Edwards Plateau) south through eastern Coahuila and the Sierra Madre of Nuevo Leon and Tamaulipas to eastern San Luis Potosi.

Cheilanthes horridula Maxon, Amer. Fern. Jour. **8**: 94 (1918).

Cheilanthes aspera Hook. Sp. Fil. **2**: 111, *t. 108a* (1852), non Kaulf. (1831).

COAHUILA: Mountains 24 mi. northeast of Monclova, 1880, *Palmer 1422*; hillside 2 mi. west of Sacramento, road to Cuatro Ciénegas, *Johnston 7092*; Sierra Gavia, 5 mi. north of Saucillo, under rocks on slope, *Johnston 7207*; Saltillo, Sierra del Pueblo, crevices, 1904, *Palmer 433* in pt.; General Cepeda, high bluff, *Palmer 326* in pt.; Picachos Colorados, under rocks below cliffs, *Johnston & Muller 112*; near Santa Elena, Sierra Cruces, limestone ledges, *Johnston & Muller 204*; south base of Picacho de San José, dry arroyo bank near gypsum exposures, *Johnston & Muller 816*; open limestone canyon, 6 mi. west of Viesca, *Johnston 7743*; Las Uvas, east side Valle Acatita, frequent, *Stewart 2697*. CHIHUAHUA: Bachimba Canyon, rocky hills, Oct. 31, 1885, *Pringle 447*; 11 mi. northeast of Camargo, lava cliff, *Johnston 7903a*. DURANGO: 23 mi. north of Zaragoza, under sandstone rocks on slope, *Johnston 7793*; Raymundo Hill, Lerdo, alt. 1650 m., Nov. 25, 1911, *Chaffey 58* in pt.

A local and rather rare species, ranging from central Texas to southwestern New Mexico and Durango.

Cheilanthes moncloviensis Baker, Ann. Bot. **5**: 210 (1891).

COAHUILA: Soledad, Sept. 1880, *Palmer 1378* (ISOTYPE).

Known also from Puebla.

Cheilanthes Wrightii Hook. Sp. Fil. **2**: 87, *t. 110a* (1852).

COAHUILA: Near Santo Domingo, igneous hill, *Wynd & Mueller 472*; Sierra Cruces, Cañon Tinaja Blanca, common among grass on sunny open gravelly terrace in upper canyon, *Johnston & Muller 288*; Sierra Cruces, crest north of Puerto Bajito at head of Cañon Tinaja Blanca, common on grassy sunny rocky slope, *Stewart 1949*. CHIHUAHUA: Sierra Virulento, about rocks on crest of ridge, *Johnston 8073*; 8 mi. northwest of Cruces, sandstone cliff, *Johnston 7985*; Sierra Encinillas, 6 mi. north of Fierro, among rocks on hillside, fairly common, *Stewart 794*; rocky hills northwest of Chihuahua, Oct. 7, 1885, *Pringle 445*; 11 mi. northeast of Camargo, about lava cliff, *Johnston 7903*.

Arizona to Texas and south to Durango. In our area the species is confined to areas with igneous rocks and frequently grows with short grass on sunny gravelly terraces and slopes.

Cheilanthes meifolia D. C. Eaton, Proc. Am. Acad. **18**: 185 (1883).

COAHUILA: Rancho Agua Dulce, wooded canyon on eastern slope of Sierra San Manuel, *Wynd & Mueller 350*.

Known also from Nuevo Leon, Tamaulipas, and San Luis Potosi.

Cheilanthes Feei Moore, Ind. Fil. p. xxxviii (1857).

COAHUILA: Cañon Chojo Grande, 27 mi. southeast of Saltillo, growing out of small hole in an exposed rock at base of canyon, 1904, *Palmer 374*; Saltillo, exposed rocks, 1904, *Palmer 432*; Puerto Colorado, faces of sandstone cliffs, *Johnston 8693*; San José, crevices of north-facing basalt crags on slope, fronds flat against rock, *Johnston & Muller 981*. CHIHUAHUA: Sierra Almagre, near Ojo del Almagre, crevices on dry cliff of volcanic rock, fronds closely appressed against rock, *Johnston & Muller 1205*.

Widely distributed in western United States and extending south into adjacent Mexico.

Cheilanthes tomentosa Link, Hort Berol. **2**: 42. (1833).

COAHUILA: Sierra Hechiceros, Cañon Indio Felipe, about rocks in deep wooded canyon, *Stewart* 130 and 137, *Johnston & Muller* 1363; Rancho Agua Dulce, Sierra San Manuel, dry arroyos, *Wynd & Mueller* 337. CHIHUAHUA: Chihuahua, northwestern hills, Oct. 23, 1885, *Pringle*.

Ranging from Virginia and Georgia west to Arkansas and Arizona, and south into northern Mexico.

Cheilanthes castanea Maxon, Proc. Biol. Soc. Wash. **32**: 111 (1919).

COAHUILA: Sierra Guajes, Cañon Milagro, on cliffs, not common, *Stewart* 1711; Soledad, 1880, *Palmer* 1390 in pt.; Caracol Mt., 1880, *Palmer* 1391 in pt.; Saltillo, Apr. 1880, *Palmer* 1391; mountains 6 mi. east of Saltillo, July 1880, *Palmer* 1398; Carneros Pass, ledges, *Pringle* 2777; Carneros Pass area, 1880, *Palmer* 1390 (ISOTYPE); Sierra del Pino, La Noria, shady bushy arroyo-bank, *Johnston & Muller* 477; Sierra del Pino, high western ridge about 10 mi. north of La Noria, under rocks on crest, *Johnston & Muller* 553; Sierra Madera, Cañon del Agua, rock crevices in moist densely wooded canyon, *Muller* 3252b; Sierra Madera, Cañon Charretera, moist bushy ledges and shaded arroyos, *Johnston* 8931 and 9095; Sierra Cruces, Cañon Tinaja Blanca, shaded banks in open canyon, *Johnston & Muller* 283; Sierra Mojada, Cañon Hidalgo, slopes of canyon below crest, *Stewart* 1057; Sierra Jimulco, 10 km. northeast of Jimulco, *Stanford et al.* 43. ZACATECAS: Concepcion del Oro, high up in canyon in shady moist places, 1904, *Palmer* 260 in pt.; Concepcion del Oro, 1902, *Palmer* 388; mountain 18 km. west of Concepcion del Oro, *Stanford et al.* 577.

Ranging from Texas to Arizona and south to Zacatecas and Hidalgo.

Cheilanthes Eatoni Baker, Syn. Fil. 140 (1867).

COAHUILA: Soledad, 1880, *Palmer* 1394, 1395, 1396; east of La Rosa, *Wynd & Mueller* 43; hills near Saltillo, shaded clay bank in deep arroyo, 1898, *Palmer* 367; base of mountains southeast of Saltillo, road to Diamante Pass, limestone ledge, *Johnston* 7270; Carneros Pass area, 1880, *Palmer* 1397; 3 km. southwest of Fraile, in arroyo, *Stanford et al.* 341; Sierra Hechiceros, about rocks on sunny hillside at El Tule, *Johnston & Muller* 1308; Sierra Hechiceros, Cañon Indio Felipe, base of cliffs, not common, *Stewart* 131; south of Carricito, north-facing basalt ledges, *Johnston & Muller* 162; Sierra del Pino, Cañon Ybarra, dry hillside, *Stewart* 1875; Sierra del Pino, under rocks on ridge-crest 4 mi. northeast of La Noria, *Johnston & Muller* 653; Sierra Cruces, Cañon Tinaja Blanca, under rocks in lower canyon, *Johnston & Muller* 252; Sierra Cruces, lava crags at head of Cañon Tinaja Blanca, *Johnston & Muller* 306; Picachio de San José, crevices of cliffs, *Stewart* 1112; San José, about basalt crags on hillside, *Johnston & Muller* 980; San Antonio de los Alamos, under large lava rocks in open upper canyon, *Johnston & Muller* 903; Sierra Negras, 9 km. south of Parras, *Stanford et al.* 202 in pt.; Sierra de Parras, July 1910, *Purpus* 4609. CHIHUAHUA: Sierra Santa Eulalia, Oct. 27, 1885, *Pringle*; rocky hills near Chihuahua, Oct. 1885, *Pringle* 455 in pt.; Meoqui, *LeSueur* 1147. ZACATECAS: Cedros, canyons, *Lloyd & Kirkwood* 139.

Ranging from Oklahoma and Texas west to Arizona and south to Durango and San Luis Potosi.

Cheilanthes jamaicensis Maxon, Contr. U. S. Nat. Herb. **24**: 51 (1922).

COAHUILA: Sierra de la Gloria, March 4, 1939, *Marsh* 1964; Sierra Madera, Cañon del Agua, abundant in rock-crevices in moist densely wooded canyon, *Muller* 3252; mountains 6 mi. east of Saltillo, 1880, *Palmer* 1418 in pt.

Here first reported from Mexico; previously known only from Jamaica and from Santo Domingo (var. *domingensis* C. Chr.). The geographical distribution of the species is unusual; one would not, off hand, expect a local West Indian species to appear, apparently just as locally, in the mountains

of northeastern Mexico. However, this is not unprecedented; *C. notholaenoides*, though much more common than *C. jamaicensis* in the Mexican highlands, similarly occurs in Jamaica and Hispaniola. Since its nearest relatives are Cordilleran, *C. jamaicensis*, in spite of its rarity on the mainland, may reasonably be classed with those continental species which have outlying stations in the West Indies.

Cheilanthes myriophylla Desv. Berl. Mag. 5: 328 (1811).

CHIHUAHUA: Hills northwest of Chihuahua, cool cliffs, Oct. 16, 1886, *Pringle* 829. ZACATECAS: Concepcion del Oro, shaded moist places among rocks and bushes high in canyon, Aug. 1904, *Palmer* 260 in pt. and 258.

Ranging from our area to Durango and San Luis Potosi and along the Andes to Chile and Argentina. Differing from *C. villosa* in having the upper surface of the fronds glabrous (rather than bearing coarse hairs) and scales of the lower surface fibrillose.

Cheilanthes villosa Davenp. Cat. Davenport Herb. Suppl. 45 (1883).

COAHUILA: Sierra Guajes, Cañon Milagro, on cliffs, not common, *Stewart* 1709; gorge just east of Socorro, on cliffs, *Johnston* 8850; Sierra San Vicente, Cañon Espantosa, *Schroeder* 97; top of grade at Cuesta Zozaya, about rocks on dry open slopes, *Johnston* 9292; western extremity of Sierra Madera, deep canyon 2 km. south-east of Puertecito, ledges on canyon-wall, *Johnston* 9320; Sierra Cruces, basalt crags at head of Cañon Tinaja Blanca, *Johnston & Muller* 306; San José, about crags on basalt hill, *Johnston & Muller* 979; San Antonio de los Alamos, under basalt rocks in open canyon, *Johnston & Muller* 904; La Botica, limestone cliffs, scarce, *Stewart* 2895; Sierras Negras, 9 km. south of Parras, *Stanford et al.* 202 in pt.; Picacho de Jimulco, summit, *Stanford et al.* 106 in pt.; Jimulco, April 28, 1885, *Pringle*. CHIHUAHUA: Sierra Rica, Dec. 1882, *Newberry*; 8 mi. northwest of Cruces, about tuff cliff, *Johnston* 7978; Sierra Santa Eulalia, April 6, 1885, *Pringle*; Sierra Santa Eulalia, Nov. 2, 1885, *Pringle* 459; hills west of Chihuahua, about head of aqueduct, May 8, 1885, *Pringle*.

Ranging from trans-Pecos Texas (Davis Mts.) to southern Arizona, and south into our area.

Cheilanthes Lindheimeri Hook. Sp. Fil. 2: 101. t. 107a (1858).

CHIHUAHUA: 1 mi. west of Poza de Villa, under rocks on small igneous hill, *Johnston & Muller* 1386; 3 mi. south of Pirámide, terrace along rocky arroyo, under rocks, *Johnston* 8113; 11 mi. northeast of Camargo, lava cliff, *Johnston* 7924; Chihuahua, rock-crevices, shady riverbank, 1908, *Palmer* 358.

Texas to Arizona and south to Sonora, Durango, and San Luis Potosi. In our region found only in areas of igneous rock.

Cheilanthes lendigera (Cav.) Sw. Syn. Fil. 128, 328 (1806).

CHIHUAHUA: Mapula Mts., southwest of Mapula station, central canyon on shaded ledges and cool cliffs, Oct. 21, 1886, *Pringle* 828 and 835.

Texas (Chisos Mts.); Arizona south along the western Sierra Madre, reaching northwestern South America.

Cheilanthes mexicana Davenp. Bull. Torr. Bot. Cl. 15: 227 (1888).

CHIHUAHUA: Portrero Peak, Sierra Santa Eulalia, northeast of Mapula station, verge of a high cliff near the summit, Oct. 12, 1886, *Pringle* 827 (TYPE).

Only the type collection seen. Although, in describing the species, Davenport compared it with *C. viscida* and *C. Parishii*, it is much more

closely related to *C. lendigera* and *C. Schaffneri* Moore (*Myriopteris rufa* Fée, non *C. rufa* Don; *C. cinnamomea* D. C. Eaton). From the former it differs in its compact habit, smaller pinnules, and nearly rudimentary indusium. There seem to be no very satisfactory characters whereby to separate it from the latter as represented by *Schaffner* 911 and 914, from San Luis Potosi, referred to *C. cinnamomea* by Eaton; more material may show that *C. mexicana* should be reduced to synonymy under *C. Schaffneri*.

Cheilanthes pyramidalis Fée, Mém. Foug. 7: 38. t. 25, f. 3 (1857).

CHIHUAHUA: Mapula Mts., large central canyon southwest of Mapula station, cool rocky slopes, Oct. 1886, *Pringle* 832.

Previous students of ferns have usually treated *C. pyramidalis* as a synonym of *C. marginata*; even Fournier treated it as only varietally distinct. It is not a very strong species. True *C. marginata* of South America, however, has a broadly deltoid lamina, ovate to short-linear ultimate segments, and strongly ciliate indusia which are usually decurrent on the rachillae. *Cheilanthes pyramidalis* of Mexico is distinguishable by its narrowly deltoid to deltoid-lanceolate lamina and its strong tendency to develop elongate-linear ultimate segments. There is much variation in the degree of ciliation and decurrence of the indusium (in Fée's type, as he figures it, it is strongly ciliate but not at all decurrent), but it is always somewhat ciliate. The species has been collected in the western states of Mexico and in Vera Cruz and Guatemala, and apparently it reappears in Venezuela (*Fendler* 90). The geographic relationship between *C. pyramidalis* and *C. marginata* is not unlike that between *Notholaena nivea* and *N. incana*. At its extreme northern limit, *C. pyramidalis* passes into var. *arizonica* (Maxon) Broun, characterized by its slender habit, deltoid-ovate lamina, elliptical to oblanceolate ultimate segments, and merely papillate-denticulate, non-decurrent indusia.

Pringle's collection (832) from the Mapula Mts. does not have the elongate segments of typical *C. pyramidalis*, but it does possess relatively narrow fronds and ciliate, more or less decurrent indusia, and therefore it is referred to the typical variety rather than to var. *arizonica*. Maxon, Amer. Fern Jour. 8: 117 (1918), cites *Pringle* 1442 as intermediate in characters. There are two sheets of this collection in the Gray Herbarium, containing three individuals, two of which are very good *C. pyramidalis*. The third, though suggesting the variety, has the relatively narrow frond of the typical form, and the indusia, though only weakly decurrent, are definitely ciliate.

Cheilanthes Kaulfussii Kunze, Linnaea 13: 145 (1839).

CHIHUAHUA: Rocky hills northwest of Chihuahua, at base of cliffs in shade, *Pringle* 457 and 826.

Ranging from Central America north to Nuevo Leon, Durango, and Chihuahua; trans-Pecos Texas (Davis and Chisos Mts.).

Cheilanthes leucopoda Link, Fil. Sp. 66 (1841).

COAHUILA: Sierra Jimulco, 11 km. northeast of Jimulco, *Stanford et al.* 82; steep open north canyon, 6 mi. west of Viesca, *Johnston* 7745. CHIHUAHUA: Sierra Santa

Eulalia, in soil about ledges, 1885, *Pringle* 442. DURANGO: 7 mi. southwest of Chocolate, shaded slope, *Shreve* 9112.

From our area ranging south in Durango, reaching San Luis Potosi. It extends north to the southern escarpment of the Edwards Plateau in Texas.

Adiantum Capillus-Veneris L. Sp. Pl. 1096 (1753).

VERNACULAR NAMES: Culantrillo; Silantrillo.

COAHUILA: Muzquiz, *Marsh* 1138; Sierra Madera, Cañon del Agua, along edge of water in upper canyon, *Muller* 3249; Cuatro Ciénegas, *Marsh* 2021; Saltillo, 1880, *Palmer* 1430; Saltillo, shady narrow arroyo, abundant on wet rocks, 1898, *Palmer* 71; Chojo Grande, 27 mi. southeast of Saltillo, common on wet canyon-wall and about waterfall, 1904, *Palmer* 360; Sierra Hechiceros, Cañon Indio Felipe, along creek and about waterfall, *Stewart* 72 and 129; Sierra Mojada, Cañon Hidalgo, shade in canyon below crest, *Stewart* 1062; El Coyote, eastern margin of Valle Acatita, frequent about spring, *Stewart* 2737; Cañon del Agua Grande west of Las Delicias, common on gypsum bank by water, *Stewart* 2801; San Lorenzo de la Laguna, 1880, *Palmer* 1431. CHIHUAHUA: Sierra Almagre, Ojo del Almagre, locally common about spring, *Johnston & Muller* 1210; Chihuahua, moist crevices on shaded river bank, 1908, *Palmer* 331. ZACATECAS: Cedros, *Lloyd & Kirkwood* 114.

Widely distributed in the warmer parts of both hemispheres. Palmer reported that this fern was sold in the market at Saltillo under the name "Silantrillo" and notes that it was "used to assist menstruations in females."

Adiantum tricholepis Fée, Mém. Foug. 8: 72 (1857).

COAHUILA: Hac. La Rosita, *Wynd & Mueller* 296; La Mariposa, *Wynd* 691. CHIHUAHUA: Sierra Santa Eulalia, April 1885, *Pringle*; rocky ledges in the hills north-east of Chihuahua, Oct. 10, 1885, *Pringle* 456.

Known from Texas (south escarpment of the Edwards Plateau), Tamaulipas, Coahuila, Nuevo Leon, Vera Cruz, Yucatan, Morelos, Guerrero, Jalisco, Sinaloa, and Chihuahua.

Polypodium peltatum Cav. Descr. 244 (1802).

Polypodium polylepis Roem. ex Kunze, *Linnaea* 13: 131 (1839).

COAHUILA: Mountain 24 km. northwest of Fraile, on a log, *Stanford et al.* 413.

Ranging northward along the eastern Sierra Madre from central and southern Mexico.

Polypodium erythrolepis Weatherby, Contr. Gray Herb. 65: 11 (1922).

COAHUILA: Cañon Sentenela, Sierra del Carmen, *Wynd & Mueller* 599 and 610; Sierra del Carmen, Aug. 26, 1936, *Marsh* 626 (US). CHIHUAHUA: Portrero Peak, northeast of Mapula station, cold cliffs, Sept. 10, 1886, *Pringle* 825 (TYPE).

Otherwise known from western Chihuahua, adjacent Sonora, and Durango. The above-cited collections from Coahuila, together with one from western Chihuahua (*LeSueur* 1128), go very far to break down the differences between *P. erythrolepis* and *P. peltatum*. In them, the abundant, ovate, deeply lacerate-margined scales of the former, which seemed so distinctive when it was proposed, nearly disappear and are replaced by suborbicular ones. The surviving distinctions are: *P. erythrolepis*, stipe nearly as long as the blade, costa green on the lower surface; *P. peltatum*, stipe conspicuously shorter than the blade, costa black on lower surface.

In addition, *P. erythrolepis* tends to have narrower rhizome-scales with narrower, more definitely erose-serrulate hyaline margins; but this is only a tendency. Furthermore, the collection here cited under *P. peltatum* (Stanford et al. 413) is also transitional in that the costa, though somewhat darker than the leaf-tissue, is green beneath and the orbicular scales of the under surface of the lamina are more or less erose-serrulate. In all probability, *P. erythrolepis* would best be treated as a variety of *P. peltatum*.

Polypodium guttatum Maxon, Contr. U. S. Nat. Herb. **17**: 575 (1916).

VERNACULAR NAME: Canahuala.

COAHUILA: Sierra del Carmen, Cañon Sentenela, Wynd & Mueller 553; Sierra Madera, Cañon Charretera, on rocks in moist shaded canyon under oaks at lower edge of pine-belt, Johnston 8985; shady canyon near Saltillo, abundant, 1898, Palmer 65 (ISOTYPE); medicinal herb bought in Saltillo market, 1898, Palmer 65½; Carneros Pass area, 1880, Palmer 1373; mountain 25 km. northwest of Fraile, Stanford et al. 371.

Ranging from Hidalgo and Guanajuato northward along the eastern Sierra Madre into eastern Coahuila; Oaxaca; Baja California. Palmer reports this plant as sold in the market at Saltillo. Infusions are drunk as tea and used externally as a remedy for pain in the joints and particularly those of the shoulder.

Polypodium plesiosorum Kunze var. **Bakeri** Davenp. Garden and Forest **4**: 556 (1891).

COAHUILA: Sierra de la Gloria, Marsh 1926.

Known from Michoacan, Jalisco, and Nuevo Leon.

Polypodium polypodioides (L.) Watt, var. **Michauxianum** Weatherby, Contr. Gray Herb. **124**: 31 (1939).

COAHUILA: Sierra San Manuel, Rancho Agua Dulce, Wynd & Mueller 368; Caracol Mts., 1880, Palmer 1376; Saltillo, Sierra del Puebla, shaded crevices of detached rocks about summit, Nov. 3, 1904, Palmer 447.

Ranging from Maryland, Illinois, and Missouri southward and through eastern Mexico to Guatemala.

Polypodium thyssanolepis A. Br. ex Klotzsch, Linnaea **20**: 392 (1847).

CHIHUAHUA: Cold cliffs in rocky hills northeast of Chihuahua, Oct. 26, 1885, Pringle 443.

Ranging from southern Arizona to western Texas (Chisos Mts.) and southward to Costa Rica and Andean South America.

SCHIZEACEAE

by C. A. WEATHERBY

Anemia mexicana Klotzsch, Linnaea **18**: 526 (1844).

COAHUILA: Rancho Agua Dulce, Sierra San Manuel, Wynd & Mueller 319; Hac. Mariposa ravine near Puerto Santa Anna, Wynd & Mueller 229; Caracol Mt., 1880, Palmer 1438.

Ranging from central Texas south to Hidalgo and Morelos.

MARSILIACEAE

by C. A. WEATHERBY

Marsilea Fournieri C. Chr. Ind. Fil. 418 (1906).

Marsilea minuta Fourn. Bull. Soc. Bot. France **27**: 329 (1880), non L. (1771).

COAHUILA: Cerro de Cypriano, July 1910, *Purpus* 4525. CHIHUAHUA: Wet places near Chihuahua, *Pringle* 1121.

The species is also known from San Luis Potosi and Jalisco. The Mexican material of *Marsilea* at hand is scanty and often without fruit or otherwise unsatisfactory; determinations in the genus are therefore tentative and subject to correction.

Marsilea mucronata A. Br. Am. Jour. Sci. II. **3**: 55. f. 2 (1847).

COAHUILA: Torreón, 1898, *Palmer* 467.

As Braun has suggested, *M. mucronata* may be no more than a variety of *M. vestita*. Baker so treated it, but without making the proper nomenclatural combination. The two are geographically separated, *M. vestita* on the Pacific Slope, *M. mucronata* in the high plains and eastern Rockies with outlying stations in the Great Basin. Within these areas the characters of pubescence given by Braun, the relatively abundant, long, slender and somewhat spreading hairs of *M. vestita*, the sparse, short, broad and appressed hairs of *M. mucronata*, hold so consistently that it seems much more natural to give *M. mucronata* some recognition than to reduce it outright to *M. vestita*, as has commonly been done in recent years.

The species ranges from southern Saskatchewan and Alberta south to Texas, New Mexico, and Arizona. Wright (2112) collected the species in low ground near San Elizario, Texas. It is to be expected elsewhere in the low ground along the Rio Grande at our northern boundary.

Marsilea sp.

CHIHUAHUA: Pond just east of Organos, growing in water up to a foot deep, blades floating on surface of pond, common, *Stewart & Johnston* 2048; Rio Conchos near Camargo, *White* 2244.

The two above-cited specimens are sterile. They suggest both *M. uncinata* and *M. mexicana* but are not definitely determinable.

PSILOTACEAE

by C. A. WEATHERBY

Psilotum nudum (L.) Griseb. Abh. Ges. Wiss. Göttingen **7**: 278 (repr. 130) (1857).

CHIHUAHUA: Hills about 8 mi. northeast of Chihuahua, growing from seams of rock in canyon, Oct. 1885, *Pringle* 450.

EQUISETACEAE

by C. A. WEATHERBY

Equisetum laevigatum A. Br. Am. Jour. Sci. **46**: 87 (1844).

COAHUILA: Muzquiz, *Marsh* 229 and 473; Sierra Hechiceros, Cañon del Indio Felipe, sand at edge of creek, scarce, *Stewart* 36.

Widely ranging in the United States and extending south through Mexico to Guatemala.

SELAGINELLACEAE

by C. A. WEATHERBY

Selaginella rupincola Underw. Bull. Torr. Bot. Cl. **25**: 129 (1898).

COAHUILA: Sierra Cruces, Cañon de Tinaja Blanca, ledges of igneous rock, stems ascending, *Johnston & Muller* 307. CHIHUAHUA: 20 km. north of Chihuahua, vol-

canic hills, rocky talus at base of cliff, more or less erect, *Stewart & Johnston* 2122; Chihuahua, 1908, *Palmer* 38 in pt.; Sierra Azul, southwest of Mapula, crevices of igneous rock, *Pennell* 18646 (US); Meoqui, 1936, *LeSueur* 1146.

Arizona and western New Mexico south along the western Sierra Madre to Durango and Guanajuato. A species apparently confined to igneous rocks. Its stems are assurgent to nearly erect and are ascendingly branched. The shoots are symmetrical and equally clothed on all sides by appressed leaves. The leaves are terminated by elongate white setae which form a conspicuous tuft at the end of sterile shoots.

Selaginella viridissima Weatherby, sp. nov.

Caules graciles, foliis inclusis circa 1 mm. diametro, elongati (ad 15 cm. longi), prostrati tegetem magnam intricatam laxam formantes, parce radicanter, bi- vel tripinnatim ramosi (spatiis inter ramos 1 cm. vel minus), ramulis plerumque brevibus (1 cm. vel minus longis). Folia uniformia, arcte adpressa, saturate viridia, plana vel leviter convexa, oblongo-lineararia, acuta vel obtusiuscula, plerumque 1.6–2 mm. longa, 0.3–0.4 mm. lata, dorso anguste sulcata, utroque margine ciliis brevissimis 0.1 mm. vel minus longis folii apicem versus ad denticulos reductis praedita. Seta terminalis nulla. Spicae apice caulis ramorumque gestae usque ad 1 cm. longae. Sporophylla ovato-delloidea, acuminata, e basi leviter dilatata subsagittata subabrupte in acuminem longam contracta, convexa, utroque margine crebre minuteque serrulato-ciliolata, 1.8–2 mm. longa, 0.3–0.4 mm. lata, sulcae medianae utroque latere vitta pallida ornata, sine seta terminali. Macrosporangia microsporangia intermixta. Macrospori 0.4–0.45 mm. diametro, flavi, dense leviterque reticulato-rugosi. Microspori aurantiaci, circa 40 μ diametro.

COAHUILA: Tinajas de los Osos, west end of Sierra Fragua, 2–3 km. north of Puerto Colorado, forming mats in shaded canyon, Sept. 1, 1941, *Johnston* 8683; Sierra Mojada, Cañon Calabasa, fairly common on shaded cliffs 100 m. below the crest, hanging in mats 1 m. in diameter, Oct. 27, 1941, *Stewart* 2204 (TYPE, Gray Herb.).

A plant with slender elongate much branched trailing stems forming loose mats. The minute dark green leaves are acute, devoid of setae, and closely appressed to the rather wiry elongate stems. It grows on limestone at the two stations where it has been collected. A pretty species, related to *S. extensa* and *S. Sartorii*, from both of which it may be distinguished by its muticous leaves. From *S. mutica* and its immediate allies, *S. viridissima* differs in its much longer, relatively narrower, and plane leaves.

Selaginella macrathera Weatherby, sp. nov.

Caules repentes, ad 8 cm. longi, usque ad apicem parce radicanter, foliis inclusis circa 1.5 mm. diametro, bipinnatim crebreque ramosi (spatiis inter ramos ca. 5 mm.). Folia uniformia, laxe adpressa, subpallide viridia, oblongo-lineararia, seta exclusa plerumque 1.8–2.2 mm. longa, 0.3–0.4 mm. lata, acuta, ventro plana, dorso leviter convexa conspicue angustequae sulcata, basi fasciculum pilorum brevium ciliis marginalibus similium margine utroque 10–12 ciliis brevissimis 0.1 mm. vel minus longis apicem folii versus ad denticulos hyalinos reductis praedita, apice in setam gracilem 1–1.4 mm. longam scabriusculam desinentia. Spicae ad 1 cm. longae apice caulis ramorumque superiorum gestae. Sporophylla anguste delloidea, 1.8–2 mm. longa, basi leviter sagittata 0.6–0.8 mm. lata, valde convexa

vix carinata, dorso leviter sulcata, marginibus breviter crebreque serrulato-ciliolata, seta ut in foliis praedita. Megasporangia absentia vel pauca, unicum visum apicem versus spicae gestum. Megaspori visi immaturi vel male evoluti aurantiaci, circa 0.3 mm. diametro, latere commissurali leviter, latere altero valde crasseque reticulato-rugosi. Microsporangia multa; microspori aurantiaci, ca. 40 μ diametro, irregulariter tuberculati.

CHIHUAHUA: Sierra del Virulento, 2-3 mi. east of Rancho Virulento, ledges on north-facing lava cliffs, common and forming mats, Aug. 11, 1941, *Johnston 8067* (TYPE, Gray Herb.).

A plant with creeping stems. The shoots are symmetrical and equally clothed on all sides with appressed leaves bearing a very long white terminal seta. In spite of its repent habit, the species apparently belongs to the group of *S. rupincola*, from all members of which it is distinguished by its combination of very short cilia and very long terminal seta.

Selaginella Wrightii Hieron. *Hedwigia* **39**: 298 (1900).

COAHUILA: El Berrendo, July 13, 1939, *Harvey 1173* (US); Sierra Gavia, 5 mi. north of Saucillo, rocky ledge, *Johnston 7208*; Sierra San Vicente, Cañon Espantosa, *Schroeder 72*; Saltillo, *Nil 10644* (US); Sierra del Pino, 4 mi. northeast of La Noria, about limestone rocks along crest of ridge, *Johnston & Muller 651*; western extremity of Sierra Madera east of Laguna de Leche, mats about limestone ledges in abrupt open canyon. *Johnston 8607*; Sierra Madera, Cañon Charretera, carpeting limestone ledges by tinaja, *Johnston 9106*; Cañon de Jara, just east of Socorro, mats about base of limestone cliffs, *Johnston 8854*; Sierra Mojada, April 19, 1892, *Jones 485* (US); 5 km. south of Sierra Mojada, *Harvey 1265a*. CHIHUAHUA: Sierra Almagre, moist limestone ledges in shaded canyon, *Johnston & Muller 1192*; east slopes of Sierra Santa Eulalia 2 km. north of San Antonio, *Harvey 1507*. ZACATECAS: Cedros, stony hills, *Lloyd & Kirkwood 142*; *Lloyd 20* (US).

Ranging from the Edwards Plateau and its escarpments, in Texas, west to southeastern New Mexico, and south through our area and the mountains of northeastern Mexico to San Luis Potosi, and possibly to Puebla. The type specimen, *Wright 829*, was collected June 25, 1849, "on hills near Turkey Creek, on flat rocks slightly covered with earth." This locality is near the present town of Cline, in western Uvalde County, Texas. The species appears to grow only on limestone. It is a creeping plant carpeting the ground under sheltering rocks or on ledges on north-facing cliffs. The erect fruiting spikes, 1-3 cm. long, are commonly produced in great abundance. The rather firm leaves have a short slightly tawny terminal seta. The leaves tend to be laterally arranged and the shoot is hence somewhat dorsi-ventral.

Selaginella Sheldoni Maxon, *Proc. Biol. Soc. Wash.* **31**: 171 (1918).

COAHUILA: Picacho de Jimulco, summit, 13 km. east of Jimulco, *Stanford et al. 118*. CHIHUAHUA: Chihuahua, 1908, *Palmer 38* in pt.

Southwestern Oklahoma, central and western Texas, and New Mexico. A creeping species with somewhat dorsi-ventral shoots. The leaves tend to be laterally spreading, and are terminated by a slender clongate white seta. Most of the known stations for the species are in areas of igneous rock.

Selaginella Parishii Underw. *Bull. Torr. Bot. Cl.* **33**: 202 (1906).

COAHUILA: Saltillo, *Nil 105* (US); Cerro Vega, west of Saltillo, crevices of sand-

stone, *Pennell 17272* (US); mountains near Saltillo, June 1909, *Nil* (US). ZACATECAS: Near Concepcion del Oro, sheltered rocky ledges, plant very dark green, 1904, *Palmer 306* (ISOTYPE); Tarey Canyon, near Cedros, clefts of slate rock, Feb. 7, 1911, *Chaffey 58* (US).

An endemic species with relatives in southern Mexico and southwestern United States (cf. Maxon, *Smithsonian Misc. Coll.* **72**: no. 5, p. 4. 1920). A prostrate repent plant with strongly dorsi-ventral shoots. The rather broad and thin acute leaves, without setae, are laterally widely spreading under favorable conditions but curve upward and become more or less connivent when dry.

The specimens here associated with the type collection of *S. Parishii* differ from it somewhat in gross appearance, and at one time they were annotated by Dr. Maxon as constituting a possible new species. In details, however, they are very close to the Palmer isotype; the more conservative course is to leave them in *S. Parishii* pending a thorough revision of the Mexican species of this group.

Selaginella lepidophylla (Hook. & Grev.) Spring, *Monog. Lycopod.* **2**: 72 (1849).

VERNACULAR NAMES: Flor de la Peña; Siempre Viva.

COAHUILA: Muzquiz-La Mariposa, Dec. 5, 1936, *Marsh 1041*; Sierra Encantada west of Buena Vista, July 14, 1938, *Marsh 1414*; 6 mi. north of Hipolito, limestone outcrop on slope, *Johnston 7236*; La Rosa, dry mountain slope, *Wynd & Mueller 45*; General Cepeda, common under overhanging ledges, 1904, *Palmer 327*; Cuatro Cieneegas, *Marsh 2056*; Cañon de Jara east of Socorro, *Schroeder 17*; western base of Picacho del Fuste, north-facing bank of cemented gravels, common, *Johnston 8442*; south end of Cañada Oscuro near Tanque La Luz, steep slopes of escarpment, common on and off gypsum beds, *Johnston 8494*; west end of Sierra Fragua, Aguaje del Pajarito, north-facing limestone slopes, *Johnston 8806*; Cañon Blanco, Sierra Margaritas, open slopes, common, *Stewart 2914*. CHIHUAHUA: Sierra San Carlos, road to mine, on cliff near canyon mouth, *Johnston & Muller 41*. ZACATECAS: Cedros, rocky hills, *Kirkwood 134*.

Western Texas and New Mexico south to southern Mexico. A common plant on north-facing dry rocky slopes and ledges in limestone areas. The plant avoids the direct sun but grows in open situations in which it can only have water available during and for a short time after desert showers. Because it avoids direct sunlight and commonly occurs in abundance only on north-facing situations, it serves as a handy and rather reliable indicator of direction to a traveller in the desert mountains where it flourishes. During most of the year the plant is an inconspicuous brownish ball of brittle inrolled leaves as big as one's fist. Only after a rain, when the fronds unroll and reveal their green upper surfaces, forming flat bright green rosettes and magically bringing unexpected verdure to gray cliffs and banks, does one realize how common and abundant it is in a region. The plant is a slow growing perennial and probably grows for a good many years. Some old plants have their rosettes lifted as much as 5 cm. above the substratum by the accumulation of half decayed fronds of seasons past. A surprising amount of dirt and gravel collects within the rosette about the base of the old fronds.

Selaginella pilifera A. Br. *Ind. Sem. Hort. Berol.* App. 20 (1857).

Selaginella Pringlei Baker, *Handb. Fern Allies* 88 (1887).

Selaginella pilifera var. *Pringlei* (Baker) Morton, Amer. Fern Jour. **29**: 15 (1939).

COAHUILA: Yerda Spring, near Muzquiz, *Marsh* 270; Muzquiz-Mariposa, *Marsh* 1042; Saltillo, *Arsène* 10677 and *Palmer* 321 (US, fide Morton); western end of Sierra Fragua, high crest north of Puerto Colorado, common on shaded ledges, *Johnston* 8748. CHIHUAHUA: Sierra Santa Eulalia, March 30, 1885, *Pringle* 211 (isotype of *S. Pringlei*); Sierra Almagre, moist shaded limestone cliffs in deep canyon, *Johnston & Muller* 1140.

Western Texas and adjacent southeastern New Mexico south to northern Sonora, San Luis Potosi, Nuevo Leon, and northern Tamaulipas. Apparently confined to limestones. A plant with habit similar to *S. lepidophylla*, but with more slender, less rigid stems and paler green, bristle-tipped leaves. In western Coahuila and adjacent Chihuahua it is uncommon and found on sheltered moderately moist cliffs in the oak-belt, and not with *Yucca*, *Dasylirion*, *Hechtia*, *Euphorbia antisiphilitica*, *Notholaena sinuata*, etc., the associates of *Selaginella lepidophylla*, on the lower and open slopes of the mountains.

The type of *S. pilifera* is given as based on "Specimina Texana in montosis ad fluvium Rio Grande infra El Paso uno cum *S. lepidophylla* a cl. Wright anno 1849 collecta comm. Dr. G. Engelmann." In the Gray Herbarium there is only a single collection of *S. lepidophylla* made by Charles Wright during 1849. This is his no. 827, collected from "high rocky bluffs of Devils River, July 22, 1849" in southern Val Verde County, Texas. His field-notes for 1849 have no entry which can be identified as pertaining to another collection of this species. It is possible, therefore, that the type of *S. pilifera* actually was collected in Val Verde County, Texas, rather than near the Rio Grande (presumably in the Quitman Mts.) below El Paso, as originally stated.

Morton has discussed the relationship of *S. pilifera* and *S. Pringlei* and has concluded that these two species differ only in trivial details, the former having entire, the latter having minutely serrulate margins on the lateral leaves. Except for the type, all the material he cites as belonging to typical *S. pilifera* comes from eastern Coahuila, Tamaulipas, and Nuevo Leon. The material from trans-Pecos Texas, New Mexico, Chihuahua, and San Luis Potosi he places in the var. *Pringlei*. Recently, however, Stephen White (522) has collected material in the valley of the Rio Bavispe, in northeastern Sonora, which has distinctly serrulate leaves. Since the characters of leaf-margin are weak at best and are not geographically correlated, it seems best to permit *S. Pringlei* to subside into synonymy.

PINACEAE

Pinus cembroides Zucc. Abh. Akad. Wiss. München **1**: 392 (1832).

Pinus osteosperma Engelm. in Wislizenus, Mem. Tour Mex. 89 (1848).

VERNACULAR NAME: Piñon.

COAHUILA: Sierra Encantada, *Stewart* 1434, *Marsh* 1358; Sierra Madera, Cañon del Agua, *Muller* 3229; Sierra del Pino, *Johnston & Muller* 523, *Stewart* 1243; Sierra Gavia, *Wynd & Mueller* 165, *Muller* 3064; Sierra San Vicente, Cañon Espantosa, *Schroeder* 95; 6 mi. east of Saltillo, 1880, *Palmer*; Chojo Grande near Saltillo, 1905, *Palmer* 768; Buena Vista, *Gregg*; Carneros Pass, *Pringle* 2659 and 4018, *Palmer*; near

General Cepeda, on mesa, *Pringle 13664*; summit of Picacho de Jimulco, *Stanford et al. 110*. CHIHUAHUA: Sierra Rica, *Stewart 2506*; Sierra Diablo, *Stewart 933*.

From Arizona, New Mexico, and trans-Pecos Texas south to Hidalgo. A small tree, usually 5–10 m. tall, commonly growing along arroyo-banks, on ridges, and on steep open slopes, usually associated with *Juniperus*. In western Coahuila and eastern Chihuahua the tree is seldom abundant in any locality.

Pinus Pinceana Gordon, Pinetum 204 (1858); Shaw, Gard. Chron. III. **38**: 122. fig. (1905), Pines of Mexico 7. tab. 2 (1909).

Pinus latissquama Engelm. Gard. Chron. II. **18**: 712. fig. (1882).

COAHUILA: West end of Sierra Fragua just north of Puerto Colorado, abundant, *Johnston 8735*; Sierras Negras, 9 km. south of Parras, *Stanford et al. 148*; General Cepeda, *Nelson 6140*; Carneros Pass, *Palmer 1299* in 1880 (type of *P. latissquama*), *Pringle 2293* and *13207A*, *Shaw*. ZACATECAS: Pico de Teira, southwest of Cedros, 1908, *Lloyd 30*.

This very well marked pinyon-pine is known only from scattered stations in our area, and from Hidalgo and the peak of Orizaba in east-central Mexico. In our region it was first collected in March 1880, in the Carneros Pass area by Palmer. His material became the type of *Pinus latissquama* Engelm. The trees, which rarely become more than 7 m. tall, have a broad rounded crown whose silhouette from a distance is more suggestive of an oak tree than a pine. The ellipsoidal cones, russet when fully ripe, are borne on stalks and at the ends of the long supple brittle pendulous branchlets. The trunk becomes 2–6 dm. thick and commonly branches less than 2 m. above the ground. The bark is grayish, somewhat furrowed on the trunk and smooth on the branches. Where it has been found, the pine grows with scrub oaks and is confined to sheltered slopes and canyons.

Pinus Ayacahuite Ehrenb. ex Schlechtend. Linnaea **12**: 492 (1838).

VERNACULAR NAMES: Acanita; Pinaveta.

COAHUILA: Sierra del Carmen, Cañon Sentenela, *Wynd & Mueller 630*; Sierra del Carmen, Sept. 12, 1936, *Marsh 821*; Sierra Madera, *Muller 3210*, *Johnston 8998*; Carneros area, March 1880, *Palmer*; sierra 26 km. northwest of Fraile, *Stanford et al. 456*; General Cepeda, *Nelson 6136*.

I have seen cones for only one of the cited collections, *Johnston 8998*. This has seeds with the wing at least 10 mm. long. The form of the species growing in the western Sierra Madre, from Arizona to Durango, has the wing on the seeds only a few millimeters in length and has been distinguished from the typical plants under the name var. *brachyptera* Shaw (= *P. strobiformis* Engelm.). Some plants from the Sierra Madre of Nuevo Leon (*Muller 1244*, *2283*) also have seeds with very short wings. The variety is probably also represented in Coahuila.

The species, with its varieties, ranges from Central America northward along the eastern Sierra Madre into Coahuila and along the western Sierra Madre into Arizona. It commonly attains a height of 15 m. and in favorable situations may approach 30 m. In Coahuila it associates with *Pseudotsuga* to form the forests on cool shaded north-slopes in the higher mountains. Along canyons and on open slopes its lower altitudinal limit is several hundred meters above that of *Pinus arizonica* and about 100 m. below that of *Pseudotsuga*.

STUDIES OF PACIFIC ISLAND PLANTS, II¹ NOTES ON THE PACIFIC SPECIES OF PIPER

A. C. SMITH

IN attempting to name a series of specimens of *Piper* L. from Fiji, kindly forwarded by the Curator of the Bernice P. Bishop Museum, it was found desirable to prepare a consideration of the known species of the genus in Fiji. In the course of this study, the species from adjacent Pacific groups were examined, and notes on two of the difficult complexes are here included. A revision of all the Pacific species is highly desirable, but this can scarcely be undertaken without examination of extensive collections and of types deposited in European herbaria. I am indebted to the authorities of the following institutions for the privilege of studying herbarium material, the place of deposit being indicated by the parenthetical letters: Arnold Arboretum (A), Bishop Museum (Bish), Gray Herbarium (GH), New York Botanical Garden (NY), University of California (UC), U. S. National Herbarium (US).

PIPER PUBERULUM (BENTH.) BENTH. AND ITS VARIETIES

The most common species of § *Macropiper* in Fiji, Samoa, and Tonga is the shrub with the following essential characters: petioles 1–4 cm. long, vaginate from one-half to nearly their entire length; leaf-blades ovate, of moderate size, generally up to 15 by 10 cm. but sometimes up to 22 by 17 cm., either puberulent beneath or glabrous on both surfaces, obtuse to rounded or subcordate at base, and with 5 or 7 (sometimes 9) nerves divergent from the petiole; spikes axillary, usually solitary but sometimes (especially in distal axils) paired, comparatively long, usually 7–17 cm. long at anthesis excluding peduncle (both staminate and pistillate), rarely 4–19 cm. long (scarcely mature when less than 7 cm.).

This is the plant commonly passing in herbaria and literature as *P. Macgillivrayi* C. DC. An examination of the various treatments of this species demonstrates that de Candolle's binomial must be replaced by *P. puberulum* (Benth.) Benth. ex Seem.

The first description referable to this species was that of Benthham in 1843, of *Macropiper puberulum*, based on a Fijian collection of Hinds and Barclay. De Candolle, in his later considerations of the species, obviously should have made use of this specific epithet, but instead he proposed the name *Piper Macgillivrayi*, which has been associated with the species through practically every consideration up to the present. That de Candolle was aware of Benthham's earlier name is obvious from his citation of *Macropiper puberulum* in synonymy, both in Seemann's *Flora Vitiensis* (1868) and in the *Prodrômus* (1869); the manuscript for Seemann's work

¹See Bull. Torrey Bot. Club 68: 397–406. 1941.

may possibly not have been seen by de Candolle before publication. In this work we find the binomial *Piper puberulum* Benth. occurring twice, once parenthetically on page 262 in the "explanation of plate 75," and again on the plate itself. This mention of *Piper puberulum*, since it is accompanied by a detailed plate, is here accepted as an authentic transfer of Benthham's *Macropiper puberulum*. I have no doubt that Seemann used the binomial *Piper puberulum* in good faith on his plate, but was deterred from taking it up in his text because of his discovery of de Candolle's manuscript name.²

Numerous varieties have been proposed within the comprehensive concept of *P. Macgillivrayi*, based upon Fijian and Samoan specimens. For the most part these varieties appear properly placed, but I believe that var. *fasciculare* Warb. (10:609) is best removed from the species to *P. Timothianum*, as stated below in my detailed consideration of the Fijian species. Var. *glabrum* Warb. (10:609) appears to be both a homonym and a synonym of var. *glabrum* C. DC.; cotype material of Warburg's variety (*Reincke 75* [US]) does not differ from the glabrous Fijian form upon which de Candolle's varietal name is based. I am unable to pass upon the proper position of the following Samoan varieties: *abbreviatum* Warb., *scandens* Warb. (for these see 10:609), *subrotundifolium* C. DC. (4:264), and *upoluanum* C. DC. (nomen?, see 5:258). Students of the Samoan flora should consider whether these are worth retaining as trinomials under *P. puberulum*.

The following varieties of *P. Macgillivrayi* have been based upon Fijian collections: *parvifolium* C. DC. and *glabrum* C. DC. (2:335). The first of these probably represents a depauperate form of the common glabrous-leaved variety of *P. puberulum*, but the second is difficult to interpret. De Candolle's description of var. *glabrum* reads merely: "foliis utrinque glabris," but the only specimen he cites is "Seemann 567 ! in h. DC." *Macropiper puberulum* Seem. in Bonplandia 1861, p. 259 is cited as a synonym. On the basis of *Seemann 567* in the Kew Herbarium, Benthham's description of *Macropiper puberulum*, and Seemann's description and plate in Flora Vitiensis (1868), one might suppose that var. *glabrum* is actually typified by the puberulent-leaved form. However, it is obvious from the varietal name and from the phrase "foliis utrinque glabris" that de Can-

²One might suspect that de Candolle avoided Benthham's specific epithet because of an earlier *Piper puberulum*, but I cannot find that this is the case. No such binomial is listed by Index Kewensis, but de Candolle, in 1923 (5:272), indexes a cryptic "*Piper puberulum* Maxim. Diagn. I, 512." This refers to *Piper puberulum* (Benth.) Maxim. in Bull. Acad. Sci. St. Pétersb. **31**: 94. 1886 [in Mém. Biol. Acad. Sci. St. Pétersb. **12**: 532. 1886], which is based on *Chavica puberula* Benth Fl. Hongk. 335. 1861. Because Maximowicz' binomial in 1886 is a later homonym of *P. puberulum* Benth. ex Seem. (1868), the Hongkong plant should be known as *Piper hongkongense* C. DC. (2:347). This latter binomial is accounted for in de Candolle's key (5:201); it is based upon a Seemann specimen. *Chavica puberula* is based upon a Hance specimen, which was the source of the misdetermination "*Piper arcuatum* Seem. Bot. Herald 415. 1857; non Miq.," cited by both Benthham and Maximowicz. As the Hance collections were deposited in Seemann's herbarium, it seems very likely that *Piper hongkongense* and *Chavica puberula* are based upon parts of the same collection.

dolle did not intend this interpretation. The specimen of *Seemann 567* in the Gray Herbarium is a mixture, having large puberulent leaves from one plant and smaller glabrous leaves from another. I believe, therefore, that de Candolle's specimen of this collection was the glabrous form, and I propose to interpret var. *glabrum* according to his obvious intent and his description, that is, excluding the synonym *Macropiper puberulum* and the puberulent-leaved portion of *Seemann 567*.

In Fiji, *P. puberulum* is divisible into two varieties, which I designate below as var. *typicum* and var. *glabrum*.

PIPER LATIFOLIUM L. F. AND ITS ALLIES

The nomenclatural confusion which has been attached to this binomial is due to the fact that it first appeared in the Emendanda to the younger Linnaeus' Supplementum Plantarum (1781) and thus replaced that author's *Piper methysticum* as described on page 91 of the same work. One is therefore justified in considering *P. methysticum* L. f. as a name published in synonymy and in taking *P. latifolium* L. f. as the correct name for the Tahitian plant described on page 91 of Linnaeus' work. This plant is characterized by its several axillary spikes and cannot be confused with the widely cultivated "kava" or "yanggona," which was first botanically described by G. Forster (Pl. Esc. Ins. Oc. Austr. 76. 1786) as *Piper methysticum*. It does not appear necessary to take Forster's name as a later homonym of *P. methysticum* L. f., which, having been corrected by the author in the same original work, has no nomenclatural status. Practically all modern taxonomists who have considered the matter are in agreement with Moore (6), whose lucid discussion of the problem indicates that *Piper methysticum* Forst. f. is the correct name for the common cultivated "kava."

In a consideration of the Pacific species of *Piper*, one of the most difficult problems is to fix the geographic limits of *P. latifolium*. Although the species was originally based on a single collection from Tahiti, numerous writers have taken the species to include plants from as far west as Tonga and the New Hebrides. This extension of the range was probably first indicated by G. Forster (Fl. Ins. Austr. Prodr. 5. 1786). C. de Candolle, in 1869 (2: 335) notes the range as "in Ins. Tahiti, ins. Societatis, Americorum, Novarum Hebridum, Timor," but subsequently (5: 172) there is an indication of uncertainty, as he states the range merely as "Tahiti, etc."

The only Tahitian specimens I have seen which match the original description and de Candolle's interpretation in his key (5: 172) are *U. S. Expl. Exped. 3*, in part (GH) and *Setchell & Parks 274* (UC), the latter being cited as such by Setchell (9: 163). Setchell implies that the species is endemic to Tahiti. However, I believe that F. Brown's reference of Marquesan specimens to *P. latifolium* (1: 17) is correct; the several specimens which Brown cites from the Austral Islands are not now available to me, and they may possibly be similar to the Raratongan plants discussed below.

Another species which must be considered in connection with *P. lati-*

folium is *P. tristachyon* C. DC. (2: 335), at least as regards its Tahitian components, the species having been based on material from both Tahiti and the Hawaiian group. According to de Candolle's key (5), *P. tristachyon* differs from *P. latifolium* primarily in its leaf-blades being pubescent beneath. The Tahitian form of *P. tristachyon* appears to be represented by *Setchell & Parks* 341 (UC) (see Setchell, 9: 163), *Tilden* 429 (GH), and *U. S. Expl. Exped.* 1 ♂ (GH). While *P. tristachyon* is superficially distinct from *P. latifolium* on the basis of its crispate-pilose lower leaf-blades and petioles, it is perilously similar in its other characters, such as leaf-shape and petioles almost completely vaginate. In general, its leaf-blades are slightly broader in proportion than those of *P. latifolium* and with less pronounced apices. The probability that these two entities are not specifically distinct is strengthened by the occurrence in Tahiti of a plant precisely resembling *P. tristachyon* in all details except its completely glabrous habit. This is represented by *U. S. Expl. Exped.* 1 ♀ (GH, US), and *Setchell & Parks* 212 (UC) and 340 (UC). The latter two specimens have been referred, and probably correctly, by Setchell (9: 163) to *P. excelsum* var. *tahitianum* C. DC. This variety appears not to be conspecific with *P. excelsum* Forst. f. of New Zealand, which has quite different leaves and has fruits immersed in the rachis (C. DC., 5: 171). I believe that *P. excelsum* var. *tahitianum* should definitely be separated from the New Zealand species and placed in the synonymy of *P. tristachyon*, of which it is no more than a glabrous form. One may consider the advisability of referring all the Tahitian plants here discussed to *P. latifolium*, which would then be characterized chiefly by its long and nearly completely vaginate petioles, broad many-nerved leaves, and several (3-5) axillary spikes.

The three Tahitian entities here discussed (*P. latifolium*, *P. tristachyon*, and *P. excelsum* var. *tahitianum*), on the basis of material now available and without consultation of the types, are kept apart only with difficulty. An essentially similar conclusion has already been expressed by Nadeaud (Enum. Pl. Indig. Tahiti 41. 1873).

The occurrence of *P. latifolium* on Raratonga in the Cook Islands has been noted by Cheeseman (in Trans. Linn. Soc. II. Bot. 6: 293. 1903) and Wilder (in Bishop Mus. Bull. 86: 38. 1931). The plant observed by them is apparently common on Raratonga and is represented by: *H. E. & S. T. Parks* 22036 (GH, UC, US), 22211 (UC), and 22301 (A, UC, US), and *Wilder* 3 (A, NY, UC). Superficially it differs from the Tahitian forms of *P. latifolium* in having its petioles only one-third to one-half vaginate; its staminate flowers have consistently 3 or 4 stamens, while those of the Tahitian specimens have either 2 or 3 stamens. For the present I have not seen enough material to decide whether a reasonable concept of *P. latifolium* may be extended to include this Raratongan form or whether the latter should be separated as a subspecific unit.

The occurrence of *P. latifolium* in the New Hebrides, noted by Forster in 1786, has been further recorded by several writers, including Miquel (Syst. Piper. 219. 1843), whose concept of the species included even such forms as *P. guahamense* C. DC. (2: 336). Guillaumin has more recently men-

tioned *P. latifolium* from the New Hebrides (in Bull. Soc. Bot. Fr. **66**: 275. 1919, op. cit. **74**: 703. 1927, in Jour. Arnold Arb. **13**: 82. 1932). Among the specimens upon which Guillaumin's concept was based, *Kajewski* 3, 436, and 718 (all A) are available to me, and the most detailed examination fails to reveal any consequential characters by which this New Hebrides plant can be distinguished from a concept of *P. latifolium* which includes the various Tahitian and Raratongan forms discussed above.

While my conclusions are admittedly based upon insufficient material, for the time being I follow earlier students in thus accrediting *P. latifolium* with a range extending from the Marquesas to the New Hebrides, although its absence from Fiji, among the collections now available from that group, must remain surprising. One may anticipate that examination of abundant Pacific material and comparison with the historic collections will reveal lines upon which this present concept of *P. latifolium* may be intelligibly divided.

THE FIJIAN SPECIES OF PIPER

The only previous treatment of the Fijian species of *Piper* is that of de Candolle in 1909 (3). In this paper five new Fijian species were described, two of which I cannot accurately place, the types not being available. I am able to recognize ten indigenous Fijian species, the total thus being probably twelve. An additional three species, which occur in Fiji either in cultivation or as weeds, are included in this consideration, being the first three species in my key. The indigenous Fijian species fall into the Sections *Eupiper* and *Macropiper*, as outlined by de Candolle (5). In the present treatment I describe three new species, propose a new name for *P. polystachyum* C. DC., and take up *P. puberulum* as an older name than the well-known *P. Macgillivrayi* C. DC.

Spikes leaf-opposed, solitary; leaf-blades plinerved or pinnate-nerved, at least the inner nerves partially concurrent; stipules sometimes free and then the petioles unwinged.

Inflorescence-scales copiously pilose; leaf-blades narrowly oblong-elliptic, inequilaterally rotund-subcordate at base, scabrid above, puberulent beneath (at least on nerves), pinnate-nerved, the lateral nerves 4-7 per side, ascending; weed, native to America (§*Steffensia*).....1. *P. aduncum*.

Inflorescence-scales glabrous; leaf-blades smooth above, not scabrid, plinerved, the principal nerves concurrent for less than half the length of the costa (pinnate-nerved in no. 7) (§ *Eupiper*).

Erect shrub; leaf-blades large, 13-25 × 10-20 cm. at maturity, deeply cordate at base, minutely puberulent on nerves beneath, the principal nerves 9-13, freely spreading from petiole except the 3 innermost, these loosely concurrent for 5-15 mm.; mature spikes (excl. peduncle) 2-6 cm. long; in Fiji only in cultivation.....2. *P. methysticum*.

Scandent plants (except no. 7); leaf-blades not exceeding 14 × 10 cm. (rarely toward base of liana up to 16 × 16 cm.), obtuse to shallowly cordate at base, the principal nerves 5-7, the inner ones firmly concurrent toward base.

Spikes at least 2 cm. long and usually much longer, on peduncles at least 6 mm. long; leaf-blades plinerved; scandent plants.

Fruits coalescing, fully embedded in pulp and concrescent with the rachis; filaments as broad as anthers; in Fiji only in cultivation.....3. *P. Betle*.

Fruits no more than semi-immersed in the rachis, not coalescing; filaments much narrower than anthers; indigenous in Fiji.

Stipules free, inconspicuous, 5–12 mm. long; leaf-blades with the inner nerves usually long-concurrent, the costa with obvious lateral nerves, the veinlets usually prominulous on both surfaces; ovaries and fruits semi-immersed in the rachis; stamens usually 4, sometimes 3, per flower, the anthers small, $0.15-0.25 \times 0.3-0.4$ mm. (♂ inflorescence not known in no. 5).

Plant glabrous throughout, or inflorescence-rachis sparsely pilose.....4. *P. insectifugum*.

Branchlets distally, petioles, peduncles, and leaf-blades on both surfaces crispate-hispid, the upper leaf-surface eventually subglabrescent; inflorescence-rachis densely pilose.....5. *P. crispatum*.

Stipules free or adnate to petiole, conspicuous, 15–22 mm. long; leaf-blades clearly plinerved, the inner 3 nerves concurrent for only 7–20 mm., the costa without important lateral nerves, the veinlets obscure or slightly impressed above; ovaries apparently free; stamens apparently 2 per flower, the anthers comparatively large, about 0.25×0.7 mm.....6. *P. stipulare*.

Spikes (at least ♀) 1–1.5 cm. long, on peduncles 2–4 mm. long; ovaries free, not immersed in the rachis; leaf-blades essentially pinnate-veined, with 2–4 pairs of secondaries; shrub.....7. *P. Degeneri*.

Spikes axillary; leaf-blades with nerves freely spreading from the petiole; stipules adnate to petioles, these at least partially vaginate; indigenous in Fiji (§ *Macropiper*).

Spikes solitary, sometimes paired in distal leaf-axils.

Leaf-blades hispid-pilose on both surfaces; inflorescence-scales ciliate-setose; carpels conspicuously narrowed toward apex and with obscure stigmas.....8. *P. oxycarpum*.

Leaf-blades glabrous at least above; inflorescence-scales not ciliate-setose; carpels essentially rounded at apex, with obvious stigmas.

Spikes 7–19 cm. long, excluding peduncle, rarely only 4 cm. but then scarcely mature; floral parts comparatively large, the scales 0.5–1.1 mm. in diameter; leaf-blades (7–)8–15(–22) by (3–)4–10(–17) cm., 5–9-nerved.

Leaf-blades puberulent beneath.....9a. *P. puberulum* var. *typicum*.

Leaf-blades glabrous on both surfaces.....9b. *P. puberulum* var. *glabrum*.

Spikes 2.5–5.5 cm. long at maturity, excluding peduncle; floral parts smaller, the scales 0.35–0.7 mm. in diameter; leaf-blades 6–11 by 2–5.5 cm., 3- or 5-nerved.....10. *P. melanostachyum*.

Spikes 3 or more per leaf-axil, rarely only 2.

Petioles of mature leaves 8–17 cm. long, usually vaginate only in the lower quarter; leaf-blades up to 25 by 28 cm., 11–13-nerved, cordate at base (deeply so on larger blades); spikes (at least ♂) 10–22 per leaf-axil.....11. *P. vitiense*.

Petioles shorter, 1–4.5 cm. long on mature leaves, vaginate nearly to apex or at least more than half their length; leaf-blades up to 17 by 15 cm., (5–)7–9-nerved, obtuse to subcordate at base; spikes (both ♂ and ♀) usually 3–5 per leaf-axil, rarely 2–7.

Spikes (both ♂ and ♀) 0.8–3.5 cm. long (excl. peduncle); stigmas glabrous or sparsely pilose.....12. *P. Timothianum*.

Spikes (at least ♀) 5–8 cm. long (excl. peduncle); stigmas densely and obviously pilose.....13. *P. kandavuense*.

1. **Piper** (§ *Steffensia*) **aduncum** L. Sp. Pl. 29. 1753; C. DC. in DC. Prodr. 16(1): 285. 1869; B. E. Parham in Agr. Jour. Dept. Agr. Fiji 9(3): 12. 1938.

DISTRIBUTION: Common throughout a large part of tropical America. Of recent introduction into Fiji; according to Parham, in 1938: "During the past five years this species of *Piper* has been noted as an aggressive weed plant in the south-eastern part of Viti Levu, it has apparently spread rapidly with Suva as the centre."

FIJI. VITI LEVU: Rewa: Lami, Parks 20060 (Bish); between Suva and Lami.

Gillespie 2079 (A, Bish); 4 mi. west of Suva, *MacDaniels* 1071 (Bish); *Rewa* or *Naitasiri*: Mt. Kombalevu, alt. 400 m., *Parks* 20282 (Bish).

NATIVE NAME: *Yanggona ni Onolulu* (according to Parham; i. e. "Honolulu Piper," a misnomer, as the species is probably not found in Hawaii).

As it occurs in Fiji, the plant is a shrub or slender tree up to 8 m. high, occurring on roadsides or in bush-land, most often near cultivation. It has not been reported from any other Pacific group.

2. **Piper** (§ *Eupiper*) **methysticum** Forst. f. Pl. Esc. Ins. Oc. Austr. 76. 1786, Fl. Ins. Austr. Prodr. 5. 1786; Seem. Fl. Vit. 260. 1868; C. DC. in DC. Prodr. 16(1): 354. 1869, in Candollea 1: 180. 1923; non L. f. Suppl. 91 [as synonym of *L. latifolium* L. f. in Emendanda]. 1781.

Macropiper methysticum Miq. Comm. Phyt. 36. pl. 4, D. 1840, Syst. Piper. 217. 1843; B. E. Parham in Agr. Jour. Dept. Agr. Fiji 8(1): 2. 1935.

DISTRIBUTION: Throughout the Pacific Islands from New Guinea and Micronesia eastward. The species is found only in cultivation, at least in Fiji, and its source is questionable. Doubtless it was carried eastward by the early inhabitants of the Pacific, and one may suspect that it is indigenous farther west than Fiji. Its roots are the source of the important native beverage, which, like the plant itself, passes under a multitude of native names. In Fiji both the plant and the drink are known as *yanggona* (also spelled "yaqona" or "yangona"). Forster mentioned no type specimen, giving the localities of Tahiti and the Tongan and Hawaiian groups. There appear to be no Fijian specimens in American herbaria, but the plant is found in every Fijian village where conditions are suitable.

I have cited above only the basic literature referring to *P. methysticum* and treatments specifically discussing the plant in Fiji. The nomenclatural problems pertaining to the binomial have been competently discussed by Moore (6). F. Brown's account (1: 18-19) discusses the numerous varieties cultivated in the Marquesas. Seemann (8: 260-261) has described the use of the plant in Fiji, while Parham (7) has recently written an interesting account of the species in Fiji, considering its varieties, methods of cultivation, disease-control, etc.

3. **Piper** (§ *Eupiper*) **Betle** L. Sp. Pl. 28. 1753; C. DC. in DC. Prodr. 16(1): 359. 1869, in Candollea 1: 189. 1923; Quisumbing in Philip. Jour. Sci. 43: 85. 1930; Jan in Agr. Jour. Dept. Agr. Fiji 8(4): 49. 1937.

DISTRIBUTION: Malaya to India, widely cultivated throughout the tropics. The common betel pepper is used and cultivated to a certain extent by the Indian population of Fiji, as indicated by the discussion of Jan cited above. I have seen no herbarium specimens of the plant from Fiji.

4. **Piper** (§ *Eupiper*) **insectifugum** C. DC. ex Seem. Fl. Vit. 262. 1868, in DC. Prodr. 16(1): 354. 1869; Bülow in Gartenflora 45: 575. 1896; C. DC. in Jour. Linn. Soc. Bot. 39: 164. 1909, in Candollea 1: 178. 1923.

DISTRIBUTION: Fairly common in Fiji, where it occurs in forest or open woods at elevations up to 800 m. In habit it is a subscandent shrub, becoming a high-climbing liana; hence its native name in Fiji is *wa kawa* or *wa nggawa* (i. e. climbing Piper). The occurrence of the species in Samoa is noted only by Bülow, as indicated above, and possibly it is endemic to Fiji.

FII. VITI LEVU: *Seemann* 569 ♂ (TYPE COLL., GH); *Tholo North*: Vicinity of Nandarivatu, *Degener & Ordenez* 13568 ster. (A, NY), *Degener* 14368 fr. (A, NY, UC, US), *Greenwood* 867 ster. (A); *Rewa*: Korombamba Mt., *Gillespie* 2315 ster. (A, Bish). KANDAVU: Above Namalata and Ngaloa Bays, *Smith* 75 ♂ (Bish, GH, NY, UC, US). VANUA LEVU: Mbua: Seatovo Range, *Smith* 1545 ♂ (Bish, GH, NY, UC, US); Thakaundrove: Savu Savu Bay region, *Degener & Ordenez*

13907 ♂ (A, NY, UC, US). TAVEUNI: Western slope between Somosomo and Wairiki, *Smith* 841 ♂ (Bish, GH, NY, UC, US). WITHOUT DEFINITE LOCALITY: *Gillespie* 2209 ♂ (A, Bish), 2225 ster. (Bish), 3876 ♂ (A, Bish).

This distinctive climbing species of § *Eupiper* is not correctly placed in de Candolle's key (5: 178). The stigmas are 3 and sessile, rather than 2 and on a style, while the stamens are 3 or 4 per flower. The presence of 4 stamens in flowers of § *Eupiper* is not indicated by de Candolle (5: 176), but there can be no doubt of the proper place of *P. insectifugum* in this section. Its actual alliance is difficult to ascertain, but its leaves are sometimes remarkably similar to those of *P. Betle*; in inflorescence characters the two species are quite different, and *P. Betle* is not indigenous in Fiji.

5. **Piper** (§ *Eupiper*) **crispatum** sp. nov.

Frutex scandens, ramulis apicem versus, petiolis, laminis utrinque, et pedunculis pilis stramineis vel pallide brunneis crispatis multicellulatis 0.5–1.5 mm. longis debiliter hispidis; ramulis subteretibus gracilibus nodis conspicue incrassatis et mox disarticulatis, internodiis apicem ramulorum versus 1–3.5 cm. longis; stipulis apice ramulorum lanceolatis ad 1 cm. longis hirtellis mox caducis; foliis alternatis, petiolis paullo canaliculatis 10–16 mm. longis, laminis chartaceis in sicco brunneis ovatis, 9–13 cm. longis, 6–8 cm. latis, basi inaequilateraliter rotundatis, apice gradatim acuminatis (acumine ipso 1–2 cm. longo ad apicem nervis marginalibus picto), margine integris, supra demum subglabrescentibus, plerumque 5-nerviis, nervis paullo supra basim orientibus, costa utrinque valida superne nervos secundarios laterales conspicuos utrinsecus 2–4 utrinque valde prominulos mittente, nervis secundariis marginem versus anastomosantibus, rete venularum intricato utrinque plus minusve prominulo; inflorescentiis ♀ solis visis apicem ramulorum versus oppositifoliis, pedunculis 10–17 mm. longis, spicis sub anthesi gracilibus 4–5 cm. longis, rhachi pilis multicellulatis circiter 0.5 mm. longis dense pilosa; bracteis primo imbricatis membranaceis peltatis inconspicue glanduloso-punctatis 1–1.2 mm. diametro breviter stipitatis; ovario in rhachi semi-immerso rotundato-conico sub anthesi circiter 0.4 mm. diametro, stigmatibus ut videtur 3 minutis.

DISTRIBUTION: Known only from the type collection.

FIJI. WITHOUT DEFINITE LOCALITY: *Gillespie* 3092 ♀ (A, Bish, TYPE), 1927–28 (woody vine, scrambling on tree).

Although doubtless a close relative of *P. insectifugum*, this plant seems specifically distinct by virtue of its crispate-hispid parts, as mentioned in my key. The numerous specimens of *P. insectifugum* examined bear no trace of the characteristic pubescence of the new species.

6. **Piper** (§ *Eupiper*) **stipulare** sp. nov.

Frutex dioecus scandens ubique praeter rhachem inflorescentiae interdum obscure pilosam glaber, ramulis gracilibus subteretibus nodis incrassatis, internodiis apicem ramulorum versus 1.5–6 cm. longis; stipulis liberis vel raro petiolo adnatis conspicuis oblongis 15–22 mm. longis interdum subpersistentibus; foliis alternatis, petiolis gracilibus 12–17 mm. longis, laminis chartaceis in sicco brunneo-olivaceis ovatis vel elliptico-ovatis, (7–)10–14 cm. longis, (4–)6–10.5 cm. latis, basi inaequilateraliter obtusis vel rotundatis, apice cuspidato-acuminatis (acumine ipso 5–10

mm. longo), margine integris, 7-pli-nerviis, nervis cum costa supra paullo subtus valde elevatis, interioribus 7–20 mm. concurrentibus apicem attingentibus, aliis antea evanescentibus, rete venularum obscuro vel subtus leviter prominulo; inflorescentiis ♂ et ♀ apicem ramulorum versus oppositifoliis, pedunculis 7–10 mm. longis, spicis sub anthesi gracilibus 4–5 cm. longis; bracteis membranaceis peltatis obscure pellucido-punctatis 0.7–0.8 mm. diametro breviter (ad 0.2 mm.) stipitatis; staminibus ut videtur 2, antheris subsessilibus subreniformibus vel transverse ellipsoideis, circiter 0.25×0.7 mm.; ovario ut videtur libero obscure luteo-glanduloso ovoideo-subgloboso sub anthesi circiter 0.7 mm. diametro, stigmatibus 3 sessilibus 0.3 mm. longis.

DISTRIBUTION: Known only from Viti Levu.

FIJI. VITU LEVU: *Parks 20879* ♂ (Bish); *Namosi*: 2 miles from Namuamua, in woods near Namosi trail, alt. 300 m., *Gillespie 3074*, with decomposed spikes (A, Bish) (thick vine, climbing on tree); *Naitasiri*: 7.5 miles from Suva, near road past Tamavua village, in woods, alt. 150 m., *Gillespie 2423* ♀ (A, Bish, TYPE), Aug. 27, 1927.

Piper stipulare is probably most closely allied to *P. Graeffei* Warb. and the several other Samoan species of § *Eupiper* proposed by C. de Candolle. However, it is distinguished from all of these by its large and often persistent stipules and its much shorter spikes.

7. **Piper** (§ *Eupiper*) **Degeneri** A. C. Sm. in *Sargentia* **1**: 10. 1942.

DISTRIBUTION: Known only from the type collection.

FIJI. VANUA LEVU: *Thakaundrove*: Eastern drainage of Yanawai River, alt. 150 m., *Degener & Ordenez 14096* ♀ (A, TYPE, NY).

As remarked in the original consideration, this very distinct and apparently rare species has no close relatives in the Pacific.

8. **Piper** (§ *Macropiper*) **oxycarpum** C. DC. in *Jour. Linn. Soc. Bot.* **39**: 164. 1909, in *Candollea* **1**: 171. 1923.

DISTRIBUTION: Endemic to Fiji and probably limited to the higher hills in the interior of Viti Levu. The type is *Gibbs 604*, from Nandarivatu, Tholo North.

FIJI. VITI LEVU: In forest at 1250 m., *Parks 20738* ♀ (A, Bish); *Tholo North*: Nandarivatu, in open bush, alt. 1000 m., *Parks 20572* ♀ (Bish). WITHOUT DEFINITE LOCALITY: *Gillespie 3839* ♀ (Bish).

This very distinct species is at once distinguished from all other members of § *Macropiper* by having its branchlets distally, petioles, peduncles, and leaf-blades on both surfaces conspicuously hispid-pilose, its inflorescence-scales densely ciliate-setose, and its carpels conspicuously narrowed toward the apex and bearing 2 or 3 very obscure stigmas. Other essential characters of the species are as follows: petioles 1–3 cm. long, one-half to three-quarters vaginate; leaf-blades ovate, 8–17 cm. long, 5–12 cm. broad, subcordate at base, gradually acuminate at apex, 7- or sometime 9-nerved; spikes (at least ♀) solitary, 5–11 cm. long excluding peduncles, these slender, 2.5–5 cm. long. According to de Candolle the type collection is from a shrub 2 m. high.

9. **Piper** (§ *Macropiper*) **puberulum** (Benth.) Benth. ex Seem. *Fl. Vit.* 262, as synonym, and *pl.* 75. 1868; non *P. puberulum* Maxim. (1886).

Macropiper puberulum Benth. in *Hook. Lond. Jour. Bot.* **2**: 235. 1843.

Piper Macgillivrayi C. DC. ex Seem. Fl. Vit. 262. 1868; C. DC.³ in DC. Prodr. 16(1): 335. 1869; Engl. in Bot. Jahrb. 7: 450. 1886, in Forschung. "Gazelle" 4: Siphon. 25. 1889; C. DC. in Denkschr. Akad. Wiss. Wien 85: 264. 1910; Turrill in Jour. Linn. Soc. Bot. 43: 35. 1915.

DISTRIBUTION: Fiji, Samoa, Tonga, and probably some of the adjacent groups. In Fiji the species is reported as a low erect shrub up to 3 m. high, occurring at altitudes from sea-level up to 900 m. or possibly higher. Var. *typicum* occurs in thickets or on the edges of forest, apparently only below 500 m., being especially common in coastal thickets. Var. *glabrum* usually occurs in the forest and is not reported from the immediate coast. The species is known throughout Fiji as *yanggoyanggona* (often spelled "yaqoyaqona"). The two varieties recognized from Fiji are not very sharply differentiated and their value is dubious. Both varieties occur in Samoa, but I have seen only var. *glabrum* from Tonga.

The necessity of replacing the well-known binomial *P. Macgillivrayi* is pointed out in my discussion above, where I also consider the typification of the species and the two varieties which are known from Fiji.

9a. *Piper puberulum* var. *typicum* nom. nov.

Macropiper puberulum Benth. in Hook. Lond. Jour. Bot. 2: 235. 1843; Miq. Syst. Piper. 221. 1843; Seem. in Bonplandia 9: 259. 1861, in Jour. Bot. 2: 73. 1864.

Piper puberulum Benth. ex Seem. Fl. Vit. 262, as synonym, and pl. 75. 1868; Bülow in Gartenflora 45: 575, nomen. 1896.

Piper Macgillivrayi C. DC. ex Seem. Fl. Vit. 262. 1868, in Candollea 1: 172. 1923.

Foliorum laminae subtus puberulae.

Fiji. VITI LEVU: Parks 20173, in part, ♀ (Bish), 20611 ♀ (Bish); Lautoka: North of Natalau, Degener 15005 ♂ (A, NY, UC, US); Tholo West: Mbulu, Degener 15042 ♀ (A, NY, UC, US). KANDAVU: Above Namalata and Ngaloa Bays, Smith 56 ♀ (Bish, GH, NY, UC, US), 115 ♀ (Bish, GH, NY, UC, US); Mt. Mbukeye Levu, Smith 210 ♀ (Bish, GH, NY, UC, US). OVALAU: U. S. Expl. Exped. 1, in part, ♀ (GH). KORO: East coast, Smith 1105 ♀ (Bish, GH, NY, UC, US). VANUA LEVU: U. S. Expl. Exped. 1, in part ♀ (GH); Thakaundrove: Savu Savu Bay region, Degener & Ordenez 13871 fr. (A, NY, UC, US). VANUA MBALAVU: Smith 1408 ♀ (Bish, NY). FULANGA: Smith 1137 ♀ (Bish, NY). WITHOUT DEFINITE LOCALITY: Seemann 567, in part, ♀ (cotype coll. of *Piper Macgillivrayi*, GH), Prince (GH).

It should be noted that some specimens here cited (e.g. Smith 115 and Degener & Ordenez 13871) bear essentially glabrous leaves on the same branches with puberulent leaves. The possibility that the degree of pubescence is merely a concomitant of shade conditions is thus indicated, and it may be questioned whether the two varieties have any genetic foundation.

9b. *Piper puberulum* var. *glabrum* (C. DC.) comb. nov.

Piper Macgillivrayi var. *glabrum* C. DC. in DC. Prodr. 16(1): 335, excl. syn.

Macropiper puberulum. 1869; Warb. (as var. nov.) in Bot. Jahrb. 25: 609. 1898; C. DC. in Jour. Linn. Soc. Bot. 39: 162. 1909, in Denkschr. Akad. Wiss. Wien 85: 264. 1910, in Candollea 1: 172. 1923.

Piper Macgillivrayi sensu Hemsl.⁴ in Jour. Linn. Soc. Bot. 30: 189. 1894; Burkill in Jour. Linn. Soc. Bot. 35: 52. 1901.

³The cited references to *P. Macgillivrayi*, with the exception of the first, cannot be referred to a definite variety and therefore are listed under the species as an inclusive concept.

⁴The numerous Tongan specimens I have seen belong to var. *glabrum*, and it seems likely that only this variety occurs in Tonga; hence I have cited literature referring to Tongan collections here.

Leaf-blades glabrous on both surfaces.

Fiji. VITI LEVU: *Gillespie* 2687 ♀ (Bish), *Parks* 20173, in part, fr. (Bish), 20232 ♀ (Bish), 20452 fr. (A, Bish), 20731 fr. (Bish), 20735 ♀, fr. (A, Bish); Tholo North: Vicinity of Nandarivatu, *Parks* 20606 fr. (Bish), *Degener & Ordenez* 13569 fr. (A, NY, UC, US), *Degener* 14361 fr. (A), 14659 fr. (A, NY); Namosi: Voma Mt., *Gillespie* 2927 ♀ (Bish); Serua: Vicinity of Ngaloa, *Degener* 15140 ♂ (A, NY), 15179 ♂, ♀⁵ (A, NY, UC, US); Rewa: Mt. Korombamba, *Gillespie* 2235 fr. (Bish). KANDAVU: Above Namalata and Ngaloa Bays, *Smith* 167 ♀ (Bish, GH, NY, UC, US). OVALAU: *U. S. Expl. Exped.* ♀ (GH). VANUA LEVU: Thakaundrove: Savu Savu Bay region, *Smith* 331 ♀ (Bish, GH, NY, UC, US), 395 ♀, fr. (Bish, GH, NY, UC, US), *Degener & Ordenez* 13829 fr. (A, NY), 13908 ♀, fr. (A, NY, UC, US), 13967 fr. (A, NY); Maravu, near Salt Lake, *Degener & Ordenez* 14156 fr. (A, NY, UC, US). WITHOUT DEFINITE LOCALITY: *Seemann* 567, in part, ♀ (TYPE COLL. of *Piper Macgillivrayi* var. *glabrum*, GH), *Gillespie* 2697 ♀ (A, Bish), 2698 ♀ (Bish), 2914 fr. (Bish), 3004 ♂ (Bish), 3307.4 ♀ (A, Bish), 4658 ♀ (A, Bish).

10. *Piper* (§ *Macropiper*) **melanostachyum** C. DC. in Jour. Linn. Soc. Bot. **39**: 162. 1909, in *Candollea* **1**: 172. 1923.

DISTRIBUTION: Endemic to Fiji and possibly limited to Viti Levu. The type is *Gibbs* 703, from Nandarivatu, Tholo North.

Fiji. VITI LEVU: Tholo North: Nandarivatu, alt. 1000 m., *Parks* 20546 fr. (Bish); Tholo West: Uluvalu, vicinity of Mbelo, near Vatukarasa, *Tabualewa* 15556 ♂ (A, NY, UC, US); Rewa: Korombamba Mt., alt. 400–550 m., *Gillespie* 2217 ♂ (A, Bish), 2350 ♀ (A, Bish). WITHOUT DEFINITE LOCALITY: *U. S. Expl. Exped.* 3 ♂ (GH).

According to de Candolle, this is a slender shrub 1.5 m. high; the above-cited collections have no habit data. The plant probably occurs in woods or forests at middle elevations, although the *Tabualewa* and *U. S. Exploring Expedition* collections may have been obtained near sea-level. The essential characters of the species are as follows: petioles 0.8–2 cm. long, vaginate one-half or nearly all their length; leaf-blades ovate-oblong, 6–11 cm. long, 2–5.5 cm. broad, acute to obtuse at base, gradually acuminate at apex, 3- or 5-nerved from the petiole; spikes solitary, axillary, slender, short (2.5–5.5 cm. long excluding peduncle, even at anthesis or in fruit). In floral characters, *P. melanostachyum* differs from *P. puberulum* only in its slightly smaller parts, the peltate scales being 0.35–0.7 mm. in diameter; the minute stamens and the stigmas are always three.

Although this plant may be only a montane derivative from the common *P. puberulum*, I am inclined to agree with de Candolle in granting it specific status, at least until more adequate material establishes a complete series of forms between the two entities.

11. *Piper* (§ *Macropiper*) **vitiense** nom. nov.

Piper latifolium sensu Seem. Fl. Vit. 261, quoad spec. vit. 1868; non L. f.

Piper polystachyum C. DC. in Jour. Linn. Soc. Bot. **39**: 162. 1909, in *Candollea* **1**: 172. 1923; A. C. Sm. in Bishop Mus. Bull. **141**: 25. 1936; non *Piper polystachyon* Ait. Hort. Kew. **1**: 49. 1789 (= *Peperomia polystachya*).

⁵*Degener* 15179 is remarkable for its polygamo-monoecious character, some spikes having only staminate flowers while others on the same plant have hermaphrodite flowers. The latter bear three stamens around a normal ovary. This is the only specimen of § *Macropiper* I have seen with hermaphrodite flowers, but it scarcely weakens the characters of the section as defined by de Candolle (5: 171).

DISTRIBUTION: Endemic to Fiji, or possibly also in the New Hebrides. Occurring in Fiji at elevations of 600 to 1100 m. in forest, often common locally. The type is *Gibbs 794*, from Nandarivatu, Tholo North, Viti Levu.

FII. VITI LEVU: *Namosi*: Naitarandamu Mt., *Gillespie 3360* ♀ (A, Bish). VANUA LEVU: *Thakau ndrove*: Mt. Mariko, *Smith 458* ♂ (Bish, GH, NY, US). TAVEUNI: *Seemann 566* ster. (GH); Mt. Manuka, *Smith 791* ♂ (Bish, NY). WITHOUT DEFINITE LOCALITY: *Gillespie 3123* ♂ (A, Bish). See also Smith in 1936.

A new name is needed for de Candolle's species because of the earlier *Piper polystachyon* Ait. The epithets *polystachyon* and *polystachyum* must be considered orthographic variants, according to Article 70 of the International Rules of Botanical Nomenclature, 1935.

Piper vitiense, a member of the general alliance of *P. latifolium* L. f., differs from that species and its other relatives in its long-petiolate large-bladed leaves and its numerous long-pedunculate staminate inflorescences. Mature leaves of our specimens have the petioles up to 17 cm. long and the sheaths 2.5–3.5 cm. long; in general the petioles are vaginate only in the lower quarter, while *P. latifolium* has sheaths usually nearly as long as the petioles. The largest leaf-blades of *P. vitiense* now available are up to 25 by 28 cm. and 13-nerved. The number of staminate spikes in the leaf-axils is somewhat more variable than the 14 described by de Candolle. Our material shows these spikes to be about 10–22 in number, giving the species its most distinctive character. The staminate spikes are up to 6 cm. long and are borne on slender peduncles up to 5 cm. long. The only available pistillate specimen, *Gillespie 3360*, has broken detached spikes, which offer no unusual character except as to number (which one may anticipate approaches the number of staminate spikes); the stigmas are 3, as usual in this section of the genus.

12. **Piper** (§ *Macropiper*) **Timothianum** A. C. Sm. in *Sargentia* **1**: 10. 1942.

Piper Macgillivrayi var. *fasciculare* Warb. in *Bot. Jahrb.* **25**: 609, as "*fascicularis*." 1898; C. DC. in *Denkschr. Akad. Wiss. Wien* **85**: 264, as "*fascicularis*." 1910, in *Ann. Cons. Jard. Bot. Genève* **15**: 232, as "*fascicularis*." 1912; Turrill in *Jour. Linn. Soc. Bot.* **43**: 35, as "*fascicularis*." 1915; C. DC. in *Candollea* **1**: 172. 1923; Christoph. in *Bishop Mus. Bull.* **154**: 5. 1938.

Piper fascicularis (sic) vel *fasciculatum* Rechinger in *Karsten & Schenck, Vegetationsbilder* **6**: pl. 5. 1908; non *P. fasciculare* Rudge, *Pl. Guian. Rar.* **1**: 9. pl. 4. 1805 (= *Lacistema* sp.); non *P. fasciculatum* Ruiz & Pav. *Syst. Veg.* **1**: 362. 1798.

Piper Macgillivrayi var. *fascicularis* (sic) forma *b* C. DC. in *Jour. Linn. Soc. Bot.* **39**: 162. 1909.

DISTRIBUTION: Fiji and Samoa. In Fiji the species is common locally in rain-forest and ridge-thickets of Viti Levu at elevations of 550–1200 m.; it is a shrub 2–5 m. high. In Samoa (as *P. Macgillivrayi* var. *fasciculare*) it is said to occur in some abundance on Savaii and Upolu, in essentially similar habitats at elevations up to 1500 m.

FII. VITI LEVU: Tholo North: Nandarivatu, *Degener & Ordenez 13570* ♀ (A, TYPE, NY, UC, US), *Parks 20777* ♂ (Bish), 20786 fr. (Bish), *Gillespie 4214* fr. (A, Bish); Nauwanga, *Degener 14360* fr. (A, NY, UC, US), 14620 fr. (A, NY); Nandrau, *Degener 14891* fr. (A, NY); *Namosi*: Vicinity of Namosi, *Gillespie 2688* ♀ (A, Bish), *Parks 20238* fr. (Bish), 20251 fr. (Bish); Korombasambasanga Mt., *B. E. Parham 2212* fr. (A). VANUA LEVU: *Thakau ndrove - Mathuata* boundary: Korotini Range, *Smith 548* ♀ (Bish, GH, NY, UC, US). WITHOUT DEFINITE LOCALITY: *Gillespie 2782* ♀ (Bish), 3124 fr. (Bish).

In proposing this entity as a new species in 1942, I considered its simi-

larity to the Samoan plant which has been passing as *P. Macgillivrayi* var. *fasciculare*, but it seemed to me at that time, as at present, that the plant cannot be placed in "*P. Macgillivrayi*" (i.e. *P. puberulum*, as defined in the present treatment) without undue expansion of that concept. The other varieties of *P. puberulum* have the spikes usually solitary, but sometimes those at the upper nodes are paired. *Piper Timothianum*, on the other hand, has the spikes normally 3-7 per axil, very rarely 2. Several students of the Samoan flora, including Christophersen in 1938, have remarked that the number of spikes may vary from 1 to 4, but I have not observed fewer than 2 (and this very rarely) in the cited Fijian material. Furthermore the spikes (excluding peduncles), both staminate and pistillate, are only 0.8-3.5 cm. long. Christophersen finds that Samoan plants may have the pistillate spikes up to 5 cm. long and the staminate up to 10 cm. *Piper puberulum*, in the sense adopted by me, has the spikes between 4 and 19 cm. long, but the spikes of either sex are rarely less than about 7 cm. long. Although the two species are doubtless closely related and quite possibly interfertile, I fail to see how the present entity can be included in *P. puberulum* without expanding that concept to an unwarranted degree, perhaps even submerging it in *P. latifolium* L. f. Few students of *Piper* will wish to combine species to this extent, in which case the whole Section *Macropiper* would scarcely be divisible into species.

Apparently only Rechinger, in 1908, has thought *P. Macgillivrayi* var. *fasciculare* worthy of specific rank; he used the specific epithets "*fascicularis*" and "*fasciculatum*" indiscriminately, but neither is available for use in *Piper*. The plant was collected at Nandarivatu by both Gibbs and Thurn, whose specimens were referred to Warburg's variety by de Candolle and Turrill.

13. *Piper* (§ *Macropiper*) **kandavuense** sp. nov.

Frutex 3 m. altus ubique inflorescentia excepta glaber, ramulis teretibus nodis valde incrassatis, internodiis apicem ramulorum versus 2-6 cm. longis; foliis alternatis, petiolis 2-3 cm. longis fere ad apicem conspicue vaginantibus (alis 3-4 mm. latis superne ad petiolum abrupte decurrentibus), laminis chartaceis in sicco olivaceis late ovatis, 10-15 cm. longis, 8-14 cm. latis, basi truncato-subcordatis, apice cuspidato-acuminatis, margine integris, 7 (vel inconspicue 9)-nerviis, nervis e basi divergentibus utrinque conspicue elevatis, rete venularum utrinque haud prominulo; inflorescentiis ♀ solis visis in axillis foliorum apicem ramulorum versus 4 vel 5 aggregatis, pedunculis validis glabris 1-2 cm. longis, spicis paullo post anthesin 2-3 mm. diametro 5-8 cm. longis; rhachi pilis pallidis 0.2-0.4 mm. longis sparse pubescente; bracteis liberis peltatis membranae circiter 0.8 mm. diametro breviter stipitatis; ovario globoso-ellipsoideo circiter 1 mm. diametro (immaturo), apice rotundato, stigmatibus 3 patentibus circiter 0.3 mm. longis dense et conspicue brunneo-pilosis et ciliatis coronato.

DISTRIBUTION: Known only from the type collection.

FIJIAN. KANDAVU: Mt. Mbuke Levu, alt. 200-500 m., Smith 219 ♀ (Bish, GH, TYPE, NY, UC, US), Oct. 23, 1933 (shrub 3 m. high, in dense forest).

The specimen above described belongs among the allies of *P. latifolium*

L. f., but in several details it differs from my concept of that species. On the whole, it has shorter petioles than *P. latifolium*; at least on leaves of comparable size and maturity, and its petiolar sheaths are slightly broader in proportion and more abrupt distally. In the material of *P. latifolium* which I have seen from the eastern Pacific, the spikes, both staminate and pistillate, are never more than 3, but the original description states that the spikes are 5 or more; whether the original specimen was staminate or pistillate is not stated. Although the stigmas of *P. latifolium* are glandular-puberulent, they are never as conspicuously pilose as those of *Smith 219*.

In view of these differences, and especially the difference pertaining to the stigmatic character, I doubt if *Smith 219* can be referred to *P. latifolium*. No Fijian specimen which has yet come to my attention seems to agree precisely with material of *P. latifolium* from the eastern Pacific, but *Smith 219* seems closest, among Fijian plants, to Linnaeus' species, the limits of which are not yet entirely understood, as stated above.

INSUFFICIENTLY KNOWN ENTITIES FROM FIJI

PIPER (§ *Macropiper*) MACGILLIVRAYI C. DC. var. PARVIFOLIUM C. DC. in DC. Prodr. **16**(1): 335. 1869.

De Candolle's whole treatment of this is as follows: ". . . limbis 0,06 longis, 0,03 latis 5-7-nerviis . . . In ins. Fijee (Barclay ! in h. Kew.)." Leaves with these small dimensions have been observed among the available Fijian collections only on plants referred to *P. melanostachyum* C. DC., in which the leaf-blades are not 7-nerved. It seems probable that *P. Macgillivrayi* var. *parvifolium* is a very depauperate individual of *P. puberulum* var. *glabrum*.

PIPER (§ *Macropiper*) GIBBSIAE C. DC. in Jour. Linn. Soc. Bot. **39**: 163. 1909, in Candollea **1**: 173. 1923.

According to de Candolle, this species is characterized by its small leaf-blades (8×3.5 cm.), which are densely hirtellous beneath and 7-nerved, its hirtellous petioles and peduncles, its short pistillate spikes (3.5 cm. long), and especially its hirsute ovaries. On the basis of the original description this appears to be a distinct species, suggestive of *P. oxycarpum* and possibly *P. puberulum* var. *typicum*. No Fijian material available to me can be referred to *P. Gibbsiae*, which I hesitate to place without seeing the type, *Gibbs 722*, from Nandarivatu, Tholo North, Viti Levu.

PIPER (§ *Macropiper*) ERECTISPICUM C. DC. in Jour. Linn. Soc. Bot. **39**: 163. 1909, in Candollea **1**: 173. 1923.

From the original description and de Candolle's key (5: 173), one may assume that this species is a close relative of *P. Gibbsiae*, differing chiefly in its slightly larger (13×5.8 cm.) and more obviously acuminate leaf-blades, longer pistillate spikes (6 cm. long), and more sparsely pilose ovaries. Without examining the type, it is inadvisable to draw conclusions as to the value of the species, which is based on *Gibbs 599*, from Nandarivatu, Tholo North, Viti Levu.

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NOTES ON THE FLORA OF INDO-CHINA

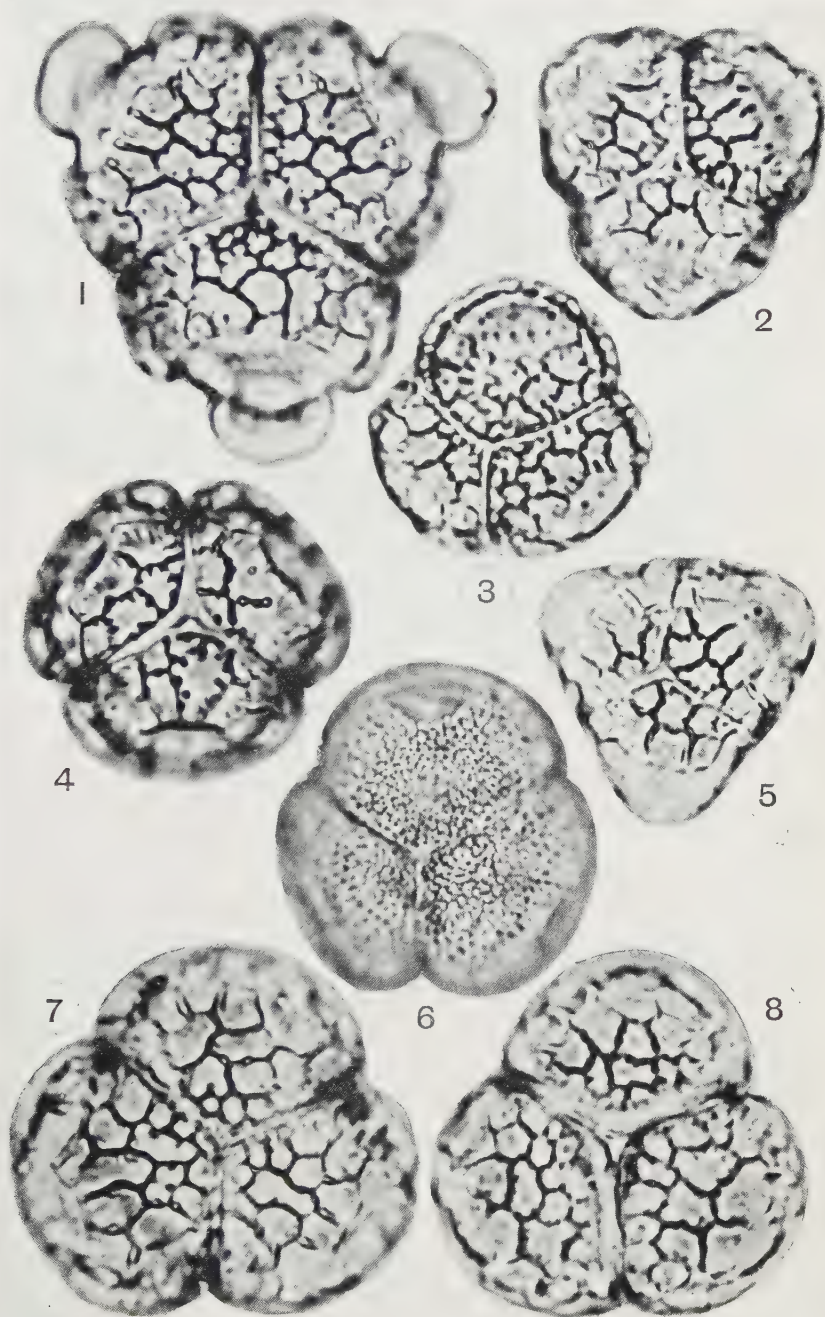
HUI-LIN LI

THIS paper is based almost entirely on a part of the very excellent and extensive collections of botanical material from the extreme northeastern part of Tonkin, adjacent to the Kwangtung border, assembled by Mr. W. T. Tsang on the second, third, and fourth Lingnan Indo-China Expeditions. These expeditions were sponsored by the Botanical Survey of Lingnan University in co-operation with the Arnold Arboretum and were supported by grants from the latter institution. The second expedition was in the fall of 1936, the third in the spring and early summer of 1939, and the fourth from May to November, 1940. All the material of the first two expeditions, when received from the field, was stored in Canton in order that the necessary herbarium labels could be prepared. The fourth expedition was actually in the field when the Japanese occupied Indo-China, but Mr. Tsang succeeded in returning to Hong Kong with all of his material. Because of the rapidly deteriorating conditions in the Orient, all of the material from the three expeditions was assembled in Hong Kong, and, through the active interest of Prof. F. A. McClure, the Arnold Arboretum share of the collections was shipped to the United States in January 1941. Because of the critical situation in Canton and the increasingly critical one in Hong Kong, time did not permit the actual transcription of the field notes for the numbers involved on the fourth and last expedition; we do, however, have the localities and the inclusive dates of collection for each locality, and we were thus in a position to have the necessary printed herbarium labels prepared.

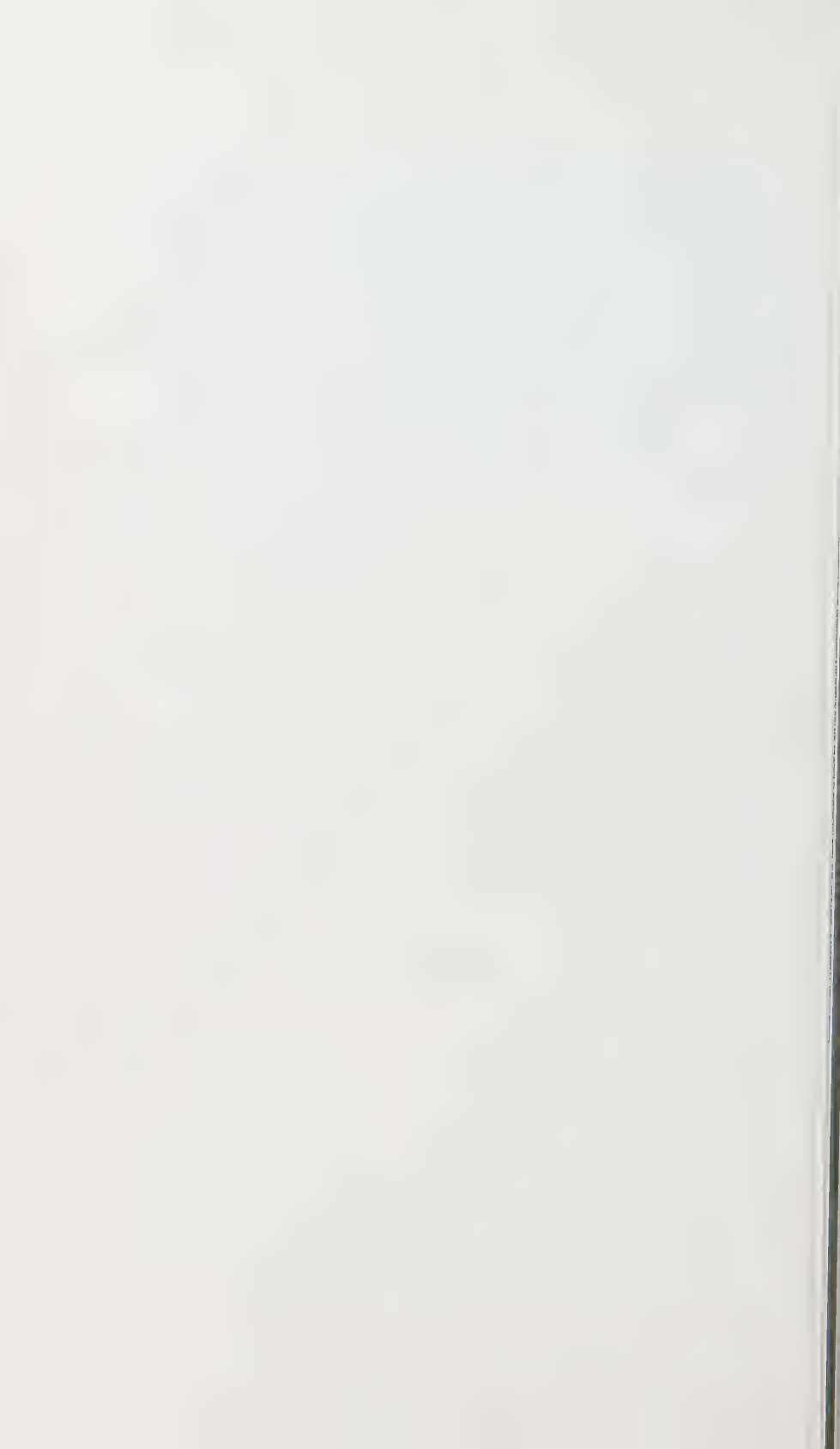
In the three collections there is a total of about 2000 numbers. Of the second and third expedition collections we normally have four sets of specimens for each number; but the number of duplicates of the fourth collection is very much larger, often running from ten to fifteen specimens for each number.

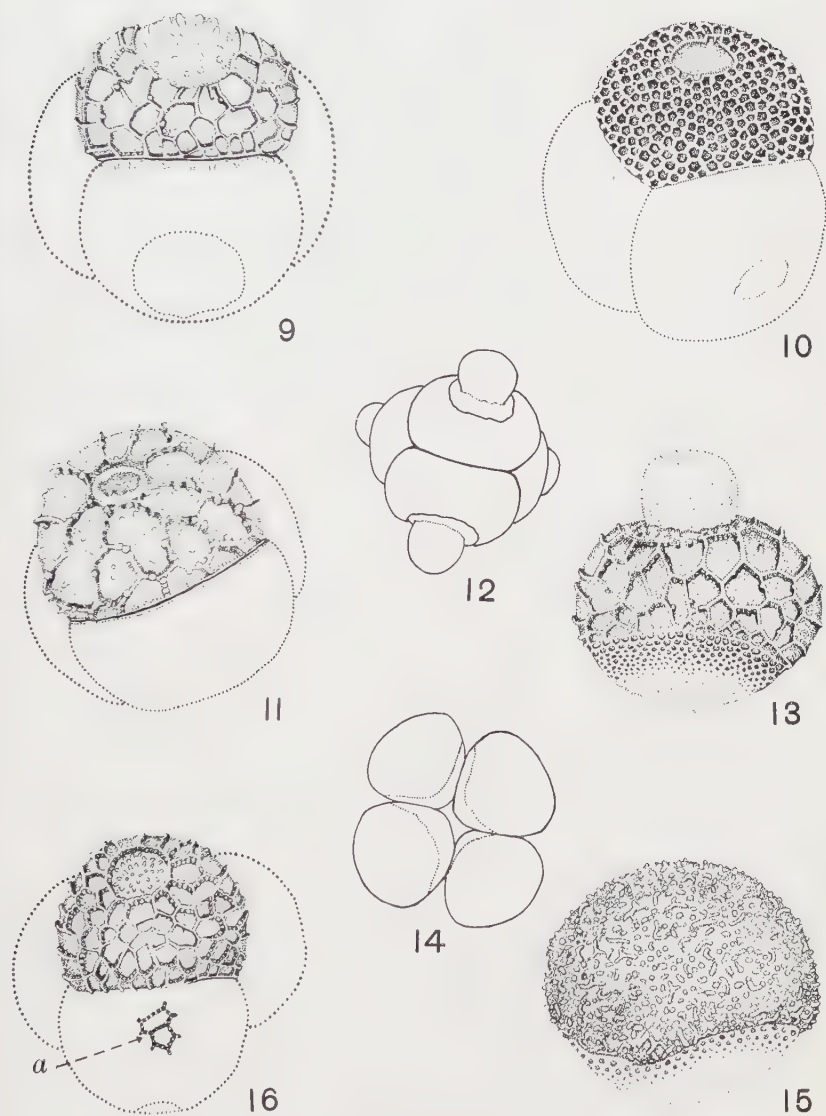
Mr. Tsang, on all three expeditions, operated in the coastal regions in the vicinity of Ha Coi and the mountainous region inland from Ha Coi and Tien Yen, much of the material being from the mountain ranges immediately south of the juncture of the Kwangsi-Kwangtung-Tonkin boundaries. Naturally, in the collection as a whole, a great many Chinese elements are represented in the form of genera and species originally described from Kwangtung, Kwangsi, and neighboring provinces, as well as the Island of Hainan. When the entire collection is studied, group by group, many additions to the Indo-Chinese flora will result. All specimens cited are deposited in the herbarium of the Arnold Arboretum.

This study was made possible through a grant made from the Milton Fund of Harvard University to Dr. E. D. Merrill, Director of the Arnold



COMPARATIVE MORPHOLOGY OF THE WINTERACEAE



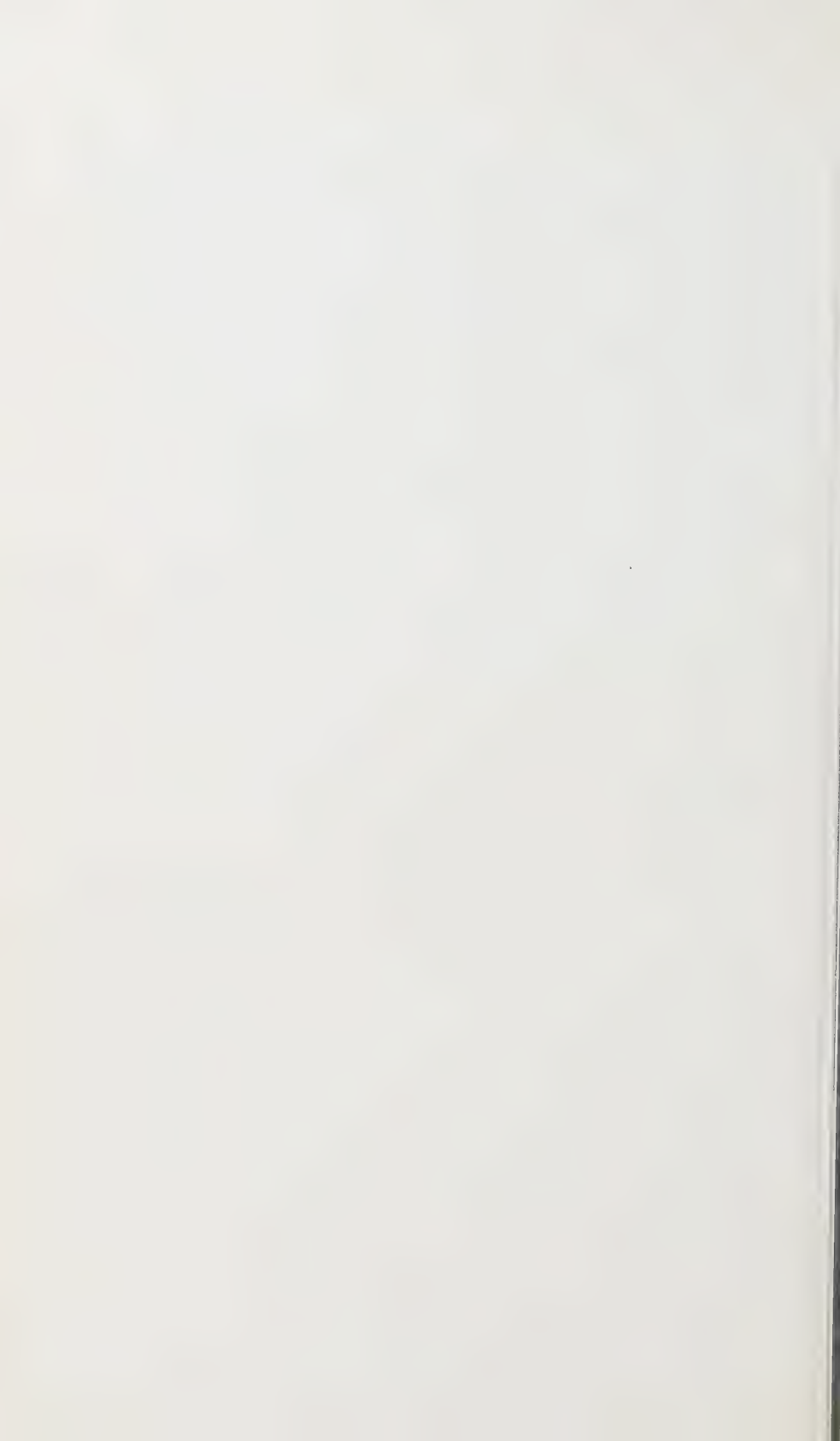


COMPARATIVE MORPHOLOGY OF THE WINTERACEAE





COMPARATIVE MORPHOLOGY OF THE WINTERACEAE



STUDIES OF PACIFIC ISLAND PLANTS, II¹

NOTES ON THE PACIFIC SPECIES OF PIPER

A. C. SMITH

IN attempting to name a series of specimens of *Piper* L. from Fiji, kindly forwarded by the Curator of the Bernice P. Bishop Museum, it was found desirable to prepare a consideration of the known species of the genus in Fiji. In the course of this study, the species from adjacent Pacific groups were examined, and notes on two of the difficult complexes are here included. A revision of all the Pacific species is highly desirable, but this can scarcely be undertaken without examination of extensive collections and of types deposited in European herbaria. I am indebted to the authorities of the following institutions for the privilege of studying herbarium material, the place of deposit being indicated by the parenthetical letters: Arnold Arboretum (A), Bishop Museum (Bish), Gray Herbarium (GH), New York Botanical Garden (NY), University of California (UC), U. S. National Herbarium (US).

PIPER PUBERULUM (BENTH.) BENTH. AND ITS VARIETIES

The most common species of § *Macropiper* in Fiji, Samoa, and Tonga is the shrub with the following essential characters: petioles 1–4 cm. long, vaginate from one-half to nearly their entire length; leaf-blades ovate, of moderate size, generally up to 15 by 10 cm. but sometimes up to 22 by 17 cm., either puberulent beneath or glabrous on both surfaces, obtuse to rounded or subcordate at base, and with 5 or 7 (sometimes 9) nerves divergent from the petiole; spikes axillary, usually solitary but sometimes (especially in distal axils) paired, comparatively long, usually 7–17 cm. long at anthesis excluding peduncle (both staminate and pistillate), rarely 4–19 cm. long (scarcely mature when less than 7 cm.).

This is the plant commonly passing in herbaria and literature as *P. Macgillivrayi* C. DC. An examination of the various treatments of this species demonstrates that de Candolle's binomial must be replaced by *P. puberulum* (Benth.) Benth. ex Seem.

The first description referable to this species was that of Benthham in 1843, of *Macropiper puberulum*, based on a Fijian collection of Hinds and Barclay. De Candolle, in his later considerations of the species, obviously should have made use of this specific epithet, but instead he proposed the name *Piper Macgillivrayi*, which has been associated with the species through practically every consideration up to the present. That de Candolle was aware of Benthham's earlier name is obvious from his citation of *Macropiper puberulum* in synonymy, both in Seemann's *Flora Vitiensis* (1868) and in the *Prodromus* (1869); the manuscript for Seemann's work

¹See Bull. Torrey Bot. Club **68**: 397–406. 1941.

may possibly not have been seen by de Candolle before publication. In this work we find the binomial *Piper puberulum* Benth. occurring twice, once parenthetically on page 262 in the "explanation of plate 75," and again on the plate itself. This mention of *Piper puberulum*, since it is accompanied by a detailed plate, is here accepted as an authentic transfer of Bentham's *Macropiper puberulum*. I have no doubt that Seemann used the binomial *Piper puberulum* in good faith on his plate, but was deterred from taking it up in his text because of his discovery of de Candolle's manuscript name.²

Numerous varieties have been proposed within the comprehensive concept of *P. Macgillivrayi*, based upon Fijian and Samoan specimens. For the most part these varieties appear properly placed, but I believe that var. *fasciculare* Warb. (10:609) is best removed from the species to *P. Timothianum*, as stated below in my detailed consideration of the Fijian species. Var. *glabrum* Warb. (10:609) appears to be both a homonym and a synonym of var. *glabrum* C. DC.; cotype material of Warburg's variety (*Reincke* 75 [US]) does not differ from the glabrous Fijian form upon which de Candolle's varietal name is based. I am unable to pass upon the proper position of the following Samoan varieties: *abbreviatum* Warb., *scandens* Warb. (for these see 10:609), *subrotundifolium* C. DC. (4:264), and *upoluanum* C. DC. (nomen?, see 5:258). Students of the Samoan flora should consider whether these are worth retaining as trinomials under *P. puberulum*.

The following varieties of *P. Macgillivrayi* have been based upon Fijian collections: *parvifolium* C. DC. and *glabrum* C. DC. (2:335). The first of these probably represents a depauperate form of the common glabrous-leaved variety of *P. puberulum*, but the second is difficult to interpret. De Candolle's description of var. *glabrum* reads merely: "foliis utrinque glabris," but the only specimen he cites is "Seemann 567 ! in h. DC." *Macropiper puberulum* Seem. in Bonplandia 1861, p. 259 is cited as a synonym. On the basis of Seemann 567 in the Kew Herbarium, Bentham's description of *Macropiper puberulum*, and Seemann's description and plate in Flora Vitiensis (1868), one might suppose that var. *glabrum* is actually typified by the puberulent-leaved form. However, it is obvious from the varietal name and from the phrase "foliis utrinque glabris" that de Can-

²One might suspect that de Candolle avoided Bentham's specific epithet because of an earlier *Piper puberulum*, but I cannot find that this is the case. No such binomial is listed by Index Kewensis, but de Candolle, in 1923 (5:272), indexes a cryptic "*Piper puberulum* Maxim. Diagn. I, 512." This refers to *Piper puberulum* (Benth.) Maxim. in Bull. Acad. Sci. St. Pétersb. **31**: 94. 1886 [in Mém. Biol. Acad. Sci. St. Pétersb. **12**: 532. 1886], which is based on *Chavica puberula* Benth. Fl. Hongk. 335. 1861. Because Maximowicz' binomial in 1886 is a later homonym of *P. puberulum* Benth. ex Seem. (1868), the Hongkong plant should be known as *Piper hongkongense* C. DC. (2:347). This latter binomial is accounted for in de Candolle's key (5:201); it is based upon a Seemann specimen. *Chavica puberula* is based upon a Hance specimen, which was the source of the misdetermination "*Piper arcuatum* Seem. Bot. Herald 415. 1857; non Miq.," cited by both Bentham and Maximowicz. As the Hance collections were deposited in Seemann's herbarium, it seems very likely that *Piper hongkongense* and *Chavica puberula* are based upon parts of the same collection.

dolle did not intend this interpretation. The specimen of *Seemann 567* in the Gray Herbarium is a mixture, having large puberulent leaves from one plant and smaller glabrous leaves from another. I believe, therefore, that de Candolle's specimen of this collection was the glabrous form, and I propose to interpret var. *glabrum* according to his obvious intent and his description, that is, excluding the synonym *Macropiper puberulum* and the puberulent-leaved portion of *Seemann 567*.

In Fiji, *P. puberulum* is divisible into two varieties, which I designate below as var. *typicum* and var. *glabrum*.

PIPER LATIFOLIUM L. F. AND ITS ALLIES

The nomenclatural confusion which has been attached to this binomial is due to the fact that it first appeared in the *Emendanda* to the younger Linnaeus' *Supplementum Plantarum* (1781) and thus replaced that author's *Piper methysticum* as described on page 91 of the same work. One is therefore justified in considering *P. methysticum* L. f. as a name published in synonymy and in taking *P. latifolium* L. f. as the correct name for the Tahitian plant described on page 91 of Linnaeus' work. This plant is characterized by its several axillary spikes and cannot be confused with the widely cultivated "kava" or "yanggona," which was first botanically described by G. Forster (*Pl. Esc. Ins. Oc. Austr.* 76. 1786) as *Piper methysticum*. It does not appear necessary to take Forster's name as a later homonym of *P. methysticum* L. f., which, having been corrected by the author in the same original work, has no nomenclatural status. Practically all modern taxonomists who have considered the matter are in agreement with Moore (6), whose lucid discussion of the problem indicates that *Piper methysticum* Forst. f. is the correct name for the common cultivated "kava."

In a consideration of the Pacific species of *Piper*, one of the most difficult problems is to fix the geographic limits of *P. latifolium*. Although the species was originally based on a single collection from Tahiti, numerous writers have taken the species to include plants from as far west as Tonga and the New Hebrides. This extension of the range was probably first indicated by G. Forster (*Fl. Ins. Austr. Prodr.* 5. 1786). C. de Candolle, in 1869 (2: 335) notes the range as "in Ins. Tahiti, ins. Societatis, Amicorum, Novarum Hebridum, Timor," but subsequently (5: 172) there is an indication of uncertainty, as he states the range merely as "Tahiti, etc."

The only Tahitian specimens I have seen which match the original description and de Candolle's interpretation in his key (5: 172) are *U. S. Expl. Exped.* 3, in part (GH) and *Setchell & Parks* 274 (UC), the latter being cited as such by Setchell (9: 163). Setchell implies that the species is endemic to Tahiti. However, I believe that F. Brown's reference of Marquesan specimens to *P. latifolium* (1: 17) is correct; the several specimens which Brown cites from the Austral Islands are not now available to me, and they may possibly be similar to the Raratongan plants discussed below.

Another species which must be considered in connection with *P. lati-*

folium is *P. tristachyon* C. DC. (2: 335), at least as regards its Tahitian components, the species having been based on material from both Tahiti and the Hawaiian group. According to de Candolle's key (5), *P. tristachyon* differs from *P. latifolium* primarily in its leaf-blades being pubescent beneath. The Tahitian form of *P. tristachyon* appears to be represented by *Setchell & Parks* 341 (UC) (see *Setchell*, 9: 163), *Tilden* 429 (GH), and *U. S. Expl. Exped.* 1 ♂ (GH). While *P. tristachyon* is superficially distinct from *P. latifolium* on the basis of its crispate-pilose lower leaf-blades and petioles, it is perilously similar in its other characters, such as leaf-shape and petioles almost completely vaginate. In general, its leaf-blades are slightly broader in proportion than those of *P. latifolium* and with less pronounced apices. The probability that these two entities are not specifically distinct is strengthened by the occurrence in Tahiti of a plant precisely resembling *P. tristachyon* in all details except its completely glabrous habit. This is represented by *U. S. Expl. Exped.* 1 ♀ (GH, US), and *Setchell & Parks* 212 (UC) and 340 (UC). The latter two specimens have been referred, and probably correctly, by *Setchell* (9: 163) to *P. excelsum* var. *tahitianum* C. DC. This variety appears not to be conspecific with *P. excelsum* Forst. f. of New Zealand, which has quite different leaves and has fruits immersed in the rachis (C. DC., 5: 171). I believe that *P. excelsum* var. *tahitianum* should definitely be separated from the New Zealand species and placed in the synonymy of *P. tristachyon*, of which it is no more than a glabrous form. One may consider the advisability of referring all the Tahitian plants here discussed to *P. latifolium*, which would then be characterized chiefly by its long and nearly completely vaginate petioles, broad many-nerved leaves, and several (3-5) axillary spikes.

The three Tahitian entities here discussed (*P. latifolium*, *P. tristachyon*, and *P. excelsum* var. *tahitianum*), on the basis of material now available and without consultation of the types, are kept apart only with difficulty. An essentially similar conclusion has already been expressed by *Nadeaud* (*Enum. Pl. Indig. Tahiti* 41. 1873).

The occurrence of *P. latifolium* on Raratonga in the Cook Islands has been noted by *Cheeseman* (in *Trans. Linn. Soc. II. Bot.* 6: 293. 1903) and *Wilder* (in *Bishop Mus. Bull.* 86: 38. 1931). The plant observed by them is apparently common on Raratonga and is represented by: *H. E. & S. T. Parks* 22036 (GH, UC, US), 22211 (UC), and 22301 (A, UC, US), and *Wilder* 3 (A, NY, UC). Superficially it differs from the Tahitian forms of *P. latifolium* in having its petioles only one-third to one-half vaginate; its staminate flowers have consistently 3 or 4 stamens, while those of the Tahitian specimens have either 2 or 3 stamens. For the present I have not seen enough material to decide whether a reasonable concept of *P. latifolium* may be extended to include this Raratongan form or whether the latter should be separated as a subspecific unit.

The occurrence of *P. latifolium* in the New Hebrides, noted by *Forster* in 1786, has been further recorded by several writers, including *Miquel* (*Syst. Piper.* 219. 1843), whose concept of the species included even such forms as *P. guahamense* C. DC. (2: 336). *Guillaumin* has more recently men-

tioned *P. latifolium* from the New Hebrides (in Bull. Soc. Bot. Fr. **66**: 275. 1919, op. cit. **74**: 703. 1927, in Jour. Arnold Arb. **13**: 82. 1932). Among the specimens upon which Guillaumin's concept was based, *Kajewski* 3, 436, and 718 (all A) are available to me, and the most detailed examination fails to reveal any consequential characters by which this New Hebrides plant can be distinguished from a concept of *P. latifolium* which includes the various Tahitian and Raratongan forms discussed above.

While my conclusions are admittedly based upon insufficient material, for the time being I follow earlier students in thus accrediting *P. latifolium* with a range extending from the Marquesas to the New Hebrides, although its absence from Fiji, among the collections now available from that group, must remain surprising. One may anticipate that examination of abundant Pacific material and comparison with the historic collections will reveal lines upon which this present concept of *P. latifolium* may be intelligibly divided.

THE FIJIAN SPECIES OF PIPER

The only previous treatment of the Fijian species of *Piper* is that of de Candolle in 1909 (3). In this paper five new Fijian species were described, two of which I cannot accurately place, the types not being available. I am able to recognize ten indigenous Fijian species, the total thus being probably twelve. An additional three species, which occur in Fiji either in cultivation or as weeds, are included in this consideration, being the first three species in my key. The indigenous Fijian species fall into the Sections *Eupiper* and *Macropiper*, as outlined by de Candolle (5). In the present treatment I describe three new species, propose a new name for *P. polystachyum* C. DC., and take up *P. puberulum* as an older name than the well-known *P. Macgillivrayi* C. DC.

Spikes leaf-opposed, solitary; leaf-blades plinerved or pinnate-nerved, at least the inner nerves partially concurrent; stipules sometimes free and then the petioles unwinged.

Inflorescence-scales copiously pilose; leaf-blades narrowly oblong-elliptic, inequilaterally rotund-subcordate at base, scabrid above, puberulent beneath (at least on nerves), pinnate-nerved, the lateral nerves 4-7 per side, ascending; weed, native to America (§*Steffensia*).....1. *P. aduncum*.

Inflorescence-scales glabrous; leaf-blades smooth above, not scabrid, plinerved, the principal nerves concurrent for less than half the length of the costa (pinnate-nerved in no. 7) (§ *Eupiper*).

Erect shrub; leaf-blades large, 13-25 × 10-20 cm. at maturity, deeply cordate at base, minutely puberulent on nerves beneath, the principal nerves 9-13, freely spreading from petiole except the 3 innermost, these loosely concurrent for 5-15 mm.; mature spikes (excl. peduncle) 2-6 cm. long; in Fiji only in cultivation.....2. *P. methysticum*.

Scandent plants (except no. 7); leaf-blades not exceeding 14 × 10 cm. (rarely toward base of liana up to 16 × 16 cm.), obtuse to shallowly cordate at base, the principal nerves 5-7, the inner ones firmly concurrent toward base.

Spikes at least 2 cm. long and usually much longer, on peduncles at least 6 mm. long; leaf-blades plinerved; scandent plants.

Fruits coalescing, fully embedded in pulp and concrescent with the rachis; filaments as broad as anthers; in Fiji only in cultivation.....3. *P. Betle*.

Fruits no more than semi-immersed in the rachis, not coalescing; filaments much narrower than anthers; indigenous in Fiji.

Stipules free, inconspicuous, 5–12 mm. long; leaf-blades with the inner nerves usually long-concurrent, the costa with obvious lateral nerves, the veinlets usually prominulous on both surfaces; ovaries and fruits semi-immersed in the rachis; stamens usually 4, sometimes 3, per flower, the anthers small, $0.15\text{--}0.25 \times 0.3\text{--}0.4$ mm. (δ inflorescence not known in no. 5).

Plant glabrous throughout, or inflorescence-rachis sparsely pilose.....4. *P. insectifugum*.

Branchlets distally, petioles, peduncles, and leaf-blades on both surfaces crispate-hispid, the upper leaf-surface eventually subglabrescent; inflorescence-rachis densely pilose.....5. *P. crispatum*.

Stipules free or adnate to petiole, conspicuous, 15–22 mm. long; leaf-blades clearly plinerved, the inner 3 nerves concurrent for only 7–20 mm., the costa without important lateral nerves, the veinlets obscure or slightly impressed above; ovaries apparently free; stamens apparently 2 per flower, the anthers comparatively large, about 0.25×0.7 mm.....6. *P. stipulare*.

Spikes (at least \varnothing) 1–1.5 cm. long, on peduncles 2–4 mm. long; ovaries free, not immersed in the rachis; leaf-blades essentially pinnate-veined, with 2–4 pairs of secondaries; shrub.....7. *P. Degeneri*.

Spikes axillary; leaf-blades with nerves freely spreading from the petiole; stipules adnate to petioles, these at least partially vaginate; indigenous in Fiji (§ *Macropiper*).

Spikes solitary, sometimes paired in distal leaf-axils.

Leaf-blades hispid-pilose on both surfaces; inflorescence-scales ciliate-setose; carpels conspicuously narrowed toward apex and with obscure stigmas.....8. *P. oxycarpum*.

Leaf-blades glabrous at least above; inflorescence-scales not ciliate-setose; carpels essentially rounded at apex, with obvious stigmas.

Spikes 7–19 cm. long, excluding peduncle, rarely only 4 cm. but then scarcely mature; floral parts comparatively large, the scales 0.5–1.1 mm. in diameter; leaf-blades (7–)8–15(–22) by (3–)4–10(–17) cm., 5–9-nerved.

Leaf-blades puberulent beneath.....9a. *P. puberulum* var. *typicum*.

Leaf-blades glabrous on both surfaces.....9b. *P. puberulum* var. *glabrum*.

Spikes 2.5–5.5 cm. long at maturity, excluding peduncle; floral parts smaller, the scales 0.35–0.7 mm. in diameter; leaf-blades 6–11 by 2–5.5 cm., 3- or 5-nerved.....10. *P. melanostachyum*.

Spikes 3 or more per leaf-axil, rarely only 2.

Petioles of mature leaves 8–17 cm. long, usually vaginate only in the lower quarter; leaf-blades up to 25 by 28 cm., 11–13-nerved, cordate at base (deeply so on larger blades); spikes (at least δ) 10–22 per leaf-axil.....11. *P. vitiense*.

Petioles shorter, 1–4.5 cm. long on mature leaves, vaginate nearly to apex or at least more than half their length; leaf-blades up to 17 by 15 cm., (5–)7–9-nerved, obtuse to subcordate at base; spikes (both δ and \varnothing) usually 3–5 per leaf-axil, rarely 2–7.

Spikes (both δ and \varnothing) 0.8–3.5 cm. long (excl. peduncle); stigmas glabrous or sparsely pilose.....12. *P. Timothianum*.

Spikes (at least \varnothing) 5–8 cm. long (excl. peduncle); stigmas densely and obviously pilose.....13. *P. kandavuense*.

1. **Piper** (§ *Steffensia*) **aduncum** L. Sp. Pl. 29. 1753; C. DC. in DC. Prodr. 16(1): 285. 1869; B. E. Parham in Agr. Jour. Dept. Agr. Fiji 9(3): 12. 1938.

DISTRIBUTION: Common throughout a large part of tropical America. Of recent introduction into Fiji; according to Parham, in 1938: "During the past five years this species of *Piper* has been noted as an aggressive weed plant in the south-eastern part of Viti Levu, it has apparently spread rapidly with Suva as the centre."

Fiji. VITI LEVU: Rewa: Lami, Parks 20060 (Bish); between Suva and Lami,

Gillespie 2079 (A, Bish); 4 mi. west of Suva, *MacDaniels* 1071 (Bish); Rewa or Naitasiri: Mt. Kombalevu, alt. 400 m., *Parks* 20282 (Bish).

NATIVE NAME: *Yanggona ni Onolulu* (according to Parham; i. e. "Honolulu Piper," a misnomer, as the species is probably not found in Hawaii).

As it occurs in Fiji, the plant is a shrub or slender tree up to 8 m. high, occurring on roadsides or in bush-land, most often near cultivation. It has not been reported from any other Pacific group.

2. **Piper** (§ *Eupiper*) **methysticum** Forst. f. Pl. Esc. Ins. Oc. Austr. 76. 1786, Fl. Ins. Austr. Prodr. 5. 1786; Seem. Fl. Vit. 260. 1868; C. DC. in DC. Prodr. 16(1): 354. 1869, in *Candollea* 1: 180. 1923; non L. f. Suppl. 91 [as synonym of *L. latifolium* L. f. in *Emendanda*]. 1781.

Macropiper methysticum Miq. Comm. Phyt. 36. pl. 4, D. 1840, Syst. Piper. 217. 1843; B. E. Parham in Agr. Jour. Dept. Agr. Fiji 8(1): 2. 1935.

DISTRIBUTION: Throughout the Pacific Islands from New Guinea and Micronesia eastward. The species is found only in cultivation, at least in Fiji, and its source is questionable. Doubtless it was carried eastward by the early inhabitants of the Pacific, and one may suspect that it is indigenous farther west than Fiji. Its roots are the source of the important native beverage, which, like the plant itself, passes under a multitude of native names. In Fiji both the plant and the drink are known as *yanggona* (also spelled "yaqona" or "yangona"). Forster mentioned no type specimen, giving the localities of Tahiti and the Tongan and Hawaiian groups. There appear to be no Fijian specimens in American herbaria, but the plant is found in every Fijian village where conditions are suitable.

I have cited above only the basic literature referring to *P. methysticum* and treatments specifically discussing the plant in Fiji. The nomenclatural problems pertaining to the binomial have been competently discussed by Moore (6). F. Brown's account (1: 18-19) discusses the numerous varieties cultivated in the Marquesas. Seemann (8: 260-261) has described the use of the plant in Fiji, while Parham (7) has recently written an interesting account of the species in Fiji, considering its varieties, methods of cultivation, disease-control, etc.

3. **Piper** (§ *Eupiper*) **Betle** L. Sp. Pl. 28. 1753; C. DC. in DC. Prodr. 16(1): 359. 1869, in *Candollea* 1: 189. 1923; Quisumbing in Philip. Jour. Sci. 43: 85. 1930; Jan in Agr. Jour. Dept. Agr. Fiji 8(4): 49. 1937.

DISTRIBUTION: Malaya to India, widely cultivated throughout the tropics. The common betel pepper is used and cultivated to a certain extent by the Indian population of Fiji, as indicated by the discussion of Jan cited above. I have seen no herbarium specimens of the plant from Fiji.

4. **Piper** (§ *Eupiper*) **insectifugum** C. DC. ex Seem. Fl. Vit. 262. 1868, in DC. Prodr. 16(1): 354. 1869; Bülow in *Gartenflora* 45: 575. 1896; C. DC. in Jour. Linn. Soc. Bot. 39: 164. 1909, in *Candollea* 1: 178. 1923.

DISTRIBUTION: Fairly common in Fiji, where it occurs in forest or open woods at elevations up to 800 m. In habit it is a subscandent shrub, becoming a high-climbing liana; hence its native name in Fiji is *wa kawa* or *wa nggawa* (i. e. climbing Piper). The occurrence of the species in Samoa is noted only by Bülow, as indicated above, and possibly it is endemic to Fiji.

Fiji. VITI LEVU: *Seemann* 569 ♂ (TYPE COLL., GH); Tholo North: Vicinity of Nandarivatu, *Degener & Ordonez* 13568 ster. (A, NY), *Degener* 14368 fr. (A, NY, UC, US), *Greenwood* 867 ster. (A); Rewa: Korombamba Mt., *Gillespie* 2315 ster. (A, Bish). KANDAVU: Above Namalata and Ngaloa Bays, *Smith* 75 ♂ (Bish, GH, NY, UC, US). VANUA LEVU: Mbua: Seatovo Range, *Smith* 1545 ♂ (Bish, GH, NY, UC, US); Thakaundrove: Savu Savu Bay region, *Degener & Ordonez*

13907 ♂ (A, NY, UC, US). TAVEUNI: Western slope between Somosomo and Wairiki, *Smith* 841 ♂ (Bish, GH, NY, UC, US). WITHOUT DEFINITE LOCALITY: *Gillespie* 2209 ♂ (A, Bish), 2225 ster. (Bish), 3876 ♂ (A, Bish).

This distinctive climbing species of § *Eupiper* is not correctly placed in de Candolle's key (5: 178). The stigmas are 3 and sessile, rather than 2 and on a style, while the stamens are 3 or 4 per flower. The presence of 4 stamens in flowers of § *Eupiper* is not indicated by de Candolle (5: 176), but there can be no doubt of the proper place of *P. insectifugum* in this section. Its actual alliance is difficult to ascertain, but its leaves are sometimes remarkably similar to those of *P. Betle*; in inflorescence characters the two species are quite different, and *P. Betle* is not indigenous in Fiji.

5. *Piper* (§ *Eupiper*) ***crispatum*** sp. nov.

Frutex scandens, ramulis apicem versus, petiolis, laminis utrinque, et pedunculis pilis stramineis vel pallide brunneis crispatis multicellulatis 0.5–1.5 mm. longis debiliter hispidis; ramulis subteretibus gracilibus nodis conspicue incrassatis et mox disarticulatis, internodiis apicem ramulorum versus 1–3.5 cm. longis; stipulis apice ramulorum lanceolatis ad 1 cm. longis hirtellis mox caducis; foliis alternatis, petiolis paullo canaliculatis 10–16 mm. longis, laminis chartaceis in sicco brunneis ovatis, 9–13 cm. longis, 6–8 cm. latis, basi inaequilateraliter rotundatis, apice gradatim acuminatis (acumine ipso 1–2 cm. longo ad apicem nervis marginalibus picto), margine integris, supra demum subglabrescentibus, plerumque 5-nerviis, nervis paullo supra basim orientibus, costa utrinque valida superne nervos secundarios laterales conspicuos utrinsecus 2–4 utrinque valde prominulos mittente, nervis secundariis marginem versus anastomosantibus, rete venularum intricato utrinque plus minusve prominulo; inflorescentiis ♀ solis visis apicem ramulorum versus oppositifoliis, pedunculis 10–17 mm. longis, spicis sub anthesi gracilibus 4–5 cm. longis, rhachi pilis multicellulatis circiter 0.5 mm. longis dense pilosa; bracteis primo imbricatis membranaceis peltatis inconspicue glanduloso-punctatis 1–1.2 mm. diametro breviter stipitatis; ovario in rhachi semi-immerso rotundato-conico sub anthesi circiter 0.4 mm. diametro, stigmatibus ut videtur 3 minutis.

DISTRIBUTION: Known only from the type collection.

Fiji. WITHOUT DEFINITE LOCALITY: *Gillespie* 3092 ♀ (A, Bish, TYPE), 1927–28 (woody vine, scrambling on tree).

Although doubtless a close relative of *P. insectifugum*, this plant seems specifically distinct by virtue of its crispate-hispid parts, as mentioned in my key. The numerous specimens of *P. insectifugum* examined bear no trace of the characteristic pubescence of the new species.

6. *Piper* (§ *Eupiper*) ***stipulare*** sp. nov.

Frutex dioecus scandens ubique praeter rhachem inflorescentiae interdum obscure pilosam glaber, ramulis gracilibus subteretibus nodis incrassatis, internodiis apicem ramulorum versus 1.5–6 cm. longis; stipulis liberis vel raro petiolo adnatis conspicuis oblongis 15–22 mm. longis interdum subpersistentibus; foliis alternatis, petiolis gracilibus 12–17 mm. longis, laminis chartaceis in sicco brunneo-olivaceis ovatis vel elliptico-ovatis, (7–)10–14 cm. longis, (4–)6–10.5 cm. latis, basi inaequilateraliter obtusis vel rotundatis, apice cuspidato-acuminatis (acumine ipso 5–10

mm. longo), margine integris, 7-pli-nerviis, nervis cum costa supra paullo subtus valde elevatis, interioribus 7–20 mm. concurrentibus apicem attingentibus, aliis antea evanescentibus, rete venularum obscuro vel subtus leviter prominulo; inflorescentiis ♂ et ♀ apicem ramulorum versus oppositifoliis, pedunculis 7–10 mm. longis, spicis sub anthesi gracilibus 4–5 cm. longis; bracteis membranaceis peltatis obscure pellucido-punctatis 0.7–0.8 mm. diametro breviter (ad 0.2 mm.) stipitatis; staminibus ut videtur 2, antheris subsessilibus subreniformibus vel transverse ellipsoideis, circiter 0.25×0.7 mm.; ovario ut videtur libero obscure luteo-glanduloso ovoideo-subgloboso sub anthesi circiter 0.7 mm. diametro, stigmatibus 3 sessilibus 0.3 mm. longis.

DISTRIBUTION: Known only from Viti Levu.

FIJL. VITU LEVU: *Parks 20879* ♂ (Bish); *Namosi*: 2 miles from Namuamua, in woods near Namosi trail, alt. 300 m., *Gillespie 3074*, with decomposed spikes (A, Bish) (thick vine, climbing on tree); *Naitasiri*: 7.5 miles from Suva, near road past Tamavua village, in woods, alt. 150 m., *Gillespie 2423* ♀ (A, Bish, TYPE), Aug. 27, 1927.

Piper stipulare is probably most closely allied to *P. Graeffei* Warb. and the several other Samoan species of § *Eupiper* proposed by C. de Candolle. However, it is distinguished from all of these by its large and often persistent stipules and its much shorter spikes.

7. **Piper** (§ *Eupiper*) **Degeneri** A. C. Sm. in *Sargentia* **1**: 10. 1942.

DISTRIBUTION: Known only from the type collection.

FIJL. VANUA LEVU: *Thakaudrove*: Eastern drainage of Yanawai River, alt. 150 m., *Degener & Ordonez 14096* ♀ (A, TYPE, NY).

As remarked in the original consideration, this very distinct and apparently rare species has no close relatives in the Pacific.

8. **Piper** (§ *Macropiper*) **oxycarpum** C. DC. in *Jour. Linn. Soc. Bot.* **39**: 164. 1909, in *Candollea* **1**: 171. 1923.

DISTRIBUTION: Endemic to Fiji and probably limited to the higher hills in the interior of Viti Levu. The type is *Gibbs 604*, from Nandarivatu, Tholo North.

FIJL. VITI LEVU: In forest at 1250 m., *Parks 20738* ♀ (A, Bish); *Tholo North*: Nandarivatu, in open bush, alt. 1000 m., *Parks 20572* ♀ (Bish). WITHOUT DEFINITE LOCALITY: *Gillespie 3839* ♀ (Bish).

This very distinct species is at once distinguished from all other members of § *Macropiper* by having its branchlets distally, petioles, peduncles, and leaf-blades on both surfaces conspicuously hispid-pilose, its inflorescence-scales densely ciliate-setose, and its carpels conspicuously narrowed toward the apex and bearing 2 or 3 very obscure stigmas. Other essential characters of the species are as follows: petioles 1–3 cm. long, one-half to three-quarters vaginate; leaf-blades ovate, 8–17 cm. long, 5–12 cm. broad, subcordate at base, gradually acuminate at apex, 7- or sometime 9-nerved; spikes (at least ♀) solitary, 5–11 cm. long excluding peduncles, these slender, 2.5–5 cm. long. According to de Candolle the type collection is from a shrub 2 m. high.

9. **Piper** (§ *Macropiper*) **puberulum** (Benth.) Benth. ex Seem. *Fl. Vit.* 262, as synonym, and *pl.* 75. 1868; non *P. puberulum* Maxim. (1886).

Macropiper puberulum Benth. in *Hook. Lond. Jour. Bot.* **2**: 235. 1843.

Piper Macgillivrayi C. DC. ex Seem. Fl. Vit. 262. 1868; C. DC.³ in DC. Prodr. 16(1): 335. 1869; Engl. in Bot. Jahrb. 7: 450. 1886, in Forschung. "Gazelle" 4: Siphon. 25. 1889; C. DC. in Denkschr. Akad. Wiss. Wien 85: 264. 1910; Turrill in Jour. Linn. Soc. Bot. 43: 35. 1915.

DISTRIBUTION: Fiji, Samoa, Tonga, and probably some of the adjacent groups. In Fiji the species is reported as a low erect shrub up to 3 m. high, occurring at altitudes from sea-level up to 900 m. or possibly higher. Var. *typicum* occurs in thickets or on the edges of forest, apparently only below 500 m., being especially common in coastal thickets. Var. *glabrum* usually occurs in the forest and is not reported from the immediate coast. The species is known throughout Fiji as *yanggoyanggon* (often spelled "yaqoyaqona"). The two varieties recognized from Fiji are not very sharply differentiated and their value is dubious. Both varieties occur in Samoa, but I have seen only var. *glabrum* from Tonga.

The necessity of replacing the well-known binomial *P. Macgillivrayi* is pointed out in my discussion above, where I also consider the typification of the species and the two varieties which are known from Fiji.

9a. *Piper puberulum* var. *typicum* nom. nov.

Macropiper puberulum Benth. in Hook. Lond. Jour. Bot. 2: 235. 1843; Miq. Syst. Piper. 221. 1843; Seem. in Bonplandia 9: 259. 1861, in Jour. Bot. 2: 73. 1864.

Piper puberulum Benth. ex Seem. Fl. Vit. 262, as synonym, and pl. 75. 1868; Bülow in Gartenflora 45: 575, nomen. 1896.

Piper Macgillivrayi C. DC. ex Seem. Fl. Vit. 262. 1868, in Candollea 1: 172. 1923.

Foliorum laminae subtus puberulae.

Fiji. VITI LEVU: Parks 20173, in part, ♀ (Bish), 20611 ♀ (Bish); Lautoka: North of Natalau, Degener 15005 ♂ (A, NY, UC, US); Tholo West: Mbulu, Degener 15042 ♀ (A, NY, UC, US). KANDAVU: Above Namalata and Ngaloa Bays, Smith 56 ♀ (Bish, GH, NY, UC, US), 115 ♀ (Bish, GH, NY, UC, US); Mt. Mbuke Levu, Smith 210 ♀ (Bish, GH, NY, UC, US). OVALAU: U. S. Expl. Exped. 1, in part, ♀ (GH). KORO: East coast, Smith 1105 ♀ (Bish, GH, NY, UC, US). VANUA LEVU: U. S. Expl. Exped. 1, in part ♀ (GH); Thakau ndrove: Savu Savu Bay region, Degener & Ordonez 13871 fr. (A, NY, UC, US). VANUA MBALAVU: Smith 1408 ♀ (Bish, NY). FULANGA: Smith 1137 ♀ (Bish, NY). WITHOUT DEFINITE LOCALITY: Seemann 567, in part, ♀ (cotype coll. of *Piper Macgillivrayi*, GH), Prince (GH).

It should be noted that some specimens here cited (e.g. Smith 115 and Degener & Ordonez 13871) bear essentially glabrous leaves on the same branches with puberulent leaves. The possibility that the degree of pubescence is merely a concomitant of shade conditions is thus indicated, and it may be questioned whether the two varieties have any genetic foundation.

9b. *Piper puberulum* var. *glabrum* (C. DC.) comb. nov.

Piper Macgillivrayi var. *glabrum* C. DC. in DC. Prodr. 16(1): 335, excl. syn. *Macropiper puberulum*. 1869; Warb. (as var. nov.) in Bot. Jahrb. 25: 609. 1898; C. DC. in Jour. Linn. Soc. Bot. 39: 162. 1909, in Denkschr. Akad. Wiss. Wien 85: 264. 1910, in Candollea 1: 172. 1923.

Piper Macgillivrayi sensu Hemsl.⁴ in Jour. Linn. Soc. Bot. 30: 189. 1894; Burkill in Jour. Linn. Soc. Bot. 35: 52. 1901.

³The cited references to *P. Macgillivrayi*, with the exception of the first, cannot be referred to a definite variety and therefore are listed under the species as an inclusive concept.

⁴The numerous Tongan specimens I have seen belong to var. *glabrum*, and it seems likely that only this variety occurs in Tonga; hence I have cited literature referring to Tongan collections here.

Leaf-blades glabrous on both surfaces.

FIJI. VITI LEVU: *Gillespie* 2687 ♀ (Bish), *Parks* 20173, in part, fr. (Bish), 20232 ♀ (Bish), 20452 fr. (A, Bish), 20731 fr. (Bish), 20735 ♀, fr. (A, Bish); Tholo North: Vicinity of Nandarivatu, *Parks* 20606 fr. (Bish), *Degener & Ordenez* 13569 fr. (A, NY, UC, US), *Degener* 14361 fr. (A), 14659 fr. (A, NY); Namosi: Voma Mt., *Gillespie* 2927 ♀ (Bish); Serua: Vicinity of Ngaloa, *Degener* 15140 ♂ (A, NY), 15179 ♂, ♀⁵ (A, NY, UC, US); Rewa: Mt. Korombamba, *Gillespie* 2235 fr. (Bish). KANDAVU: Above Namalata and Ngaloa Bays, *Smith* 167 ♀ (Bish, GH, NY, UC, US). OVALAU: *U. S. Expl. Exped.* ♀ (GH). VANUA LEVU: Thakaundrove: Savu Savu Bay region, *Smith* 331 ♀ (Bish, GH, NY, UC, US), 395 ♀, fr. (Bish, GH, NY, UC, US), *Degener & Ordenez* 13829 fr. (A, NY), 13908 ♀, fr. (A, NY, UC, US), 13967 fr. (A, NY); Maravu, near Salt Lake, *Degener & Ordenez* 14156 fr. (A, NY, UC, US). WITHOUT DEFINITE LOCALITY: *Seemann* 567, in part, ♀ (TYPE COLL. of *Piper Macgillivrayi* var. *glabrum*, GH), *Gillespie* 2697 ♀ (A, Bish), 2698 ♀ (Bish), 2914 fr. (Bish), 3004 ♂ (Bish), 3307.4 ♀ (A, Bish), 4658 ♀ (A, Bish).

10. *Piper* (§ *Macropiper*) **melanostachyum** C. DC. in Jour. Linn. Soc. Bot. **39**: 162. 1909, in Candolle **1**: 172. 1923.

DISTRIBUTION: Endemic to Fiji and possibly limited to Viti Levu. The type is *Gibbs* 703, from Nandarivatu, Tholo North.

FIJI. VITI LEVU: Tholo North: Nandarivatu, alt. 1000 m., *Parks* 20546 fr. (Bish); Tholo West: Uluvatu, vicinity of Mbalo, near Vatukarasa, *Tabualewa* 15556 ♂ (A, NY, UC, US); Rewa: Korombamba Mt., alt. 400–550 m., *Gillespie* 2217 ♂ (A, Bish), 2350 ♀ (A, Bish). WITHOUT DEFINITE LOCALITY: *U. S. Expl. Exped.* 3 ♂ (GH).

According to de Candolle, this is a slender shrub 1.5 m. high; the above-cited collections have no habit data. The plant probably occurs in woods or forests at middle elevations, although the *Tabualewa* and *U. S. Exploring Expedition* collections may have been obtained near sea-level. The essential characters of the species are as follows: petioles 0.8–2 cm. long, vaginate one-half or nearly all their length; leaf-blades ovate-oblong, 6–11 cm. long, 2–5.5 cm. broad, acute to obtuse at base, gradually acuminate at apex, 3- or 5-nerved from the petiole; spikes solitary, axillary, slender, short (2.5–5.5 cm. long excluding peduncle, even at anthesis or in fruit). In floral characters, *P. melanostachyum* differs from *P. puberulum* only in its slightly smaller parts, the peltate scales being 0.35–0.7 mm. in diameter; the minute stamens and the stigmas are always three.

Although this plant may be only a montane derivative from the common *P. puberulum*, I am inclined to agree with de Candolle in granting it specific status, at least until more adequate material establishes a complete series of forms between the two entities.

11. *Piper* (§ *Macropiper*) **vitiense** nom. nov.

Piper latifolium sensu Seem. Fl. Vit. 261, quoad spec. vit. 1868; non L. f.

Piper polystachyum C. DC. in Jour. Linn. Soc. Bot. **39**: 162. 1909, in Candolle

1: 172. 1923; A. C. Sm. in Bishop Mus. Bull. **141**: 25. 1936; non *Piper polystachyon* Ait. Hort. Kew. **1**: 49. 1789 (= *Peperomia polystachya*).

⁵*Degener* 15179 is remarkable for its polygamo-monoecious character, some spikes having only staminate flowers while others on the same plant have hermaphrodite flowers. The latter bear three stamens around a normal ovary. This is the only specimen of § *Macropiper* I have seen with hermaphrodite flowers, but it scarcely weakens the characters of the section as defined by de Candolle (5: 171).

DISTRIBUTION: Endemic to Fiji, or possibly also in the New Hebrides. Occurring in Fiji at elevations of 600 to 1100 m. in forest, often common locally. The type is Gibbs 794, from Nandarivatu, Tholo North, Viti Levu.

FIJI. VITI LEVU: Namosi: Naitarandamu Mt., Gillespie 3360 ♀ (A, Bish). VANUA LEVU: Thakauandrove: Mt. Mariko, Smith 458 ♂ (Bish, GH, NY, US). TAVEUNI: Seemann 566 ster. (GH); Mt. Manuka, Smith 791 ♂ (Bish, NY). WITHOUT DEFINITE LOCALITY: Gillespie 3123 ♂ (A, Bish). See also Smith in 1936.

A new name is needed for de Candolle's species because of the earlier *Piper polystachyon* Ait. The epithets *polystachyon* and *polystachyum* must be considered orthographic variants, according to Article 70 of the International Rules of Botanical Nomenclature, 1935.

Piper vitiense, a member of the general alliance of *P. latifolium* L. f., differs from that species and its other relatives in its long-petiolate large-bladed leaves and its numerous long-pedunculate staminate inflorescences. Mature leaves of our specimens have the petioles up to 17 cm. long and the sheaths 2.5–3.5 cm. long; in general the petioles are vaginate only in the lower quarter, while *P. latifolium* has sheaths usually nearly as long as the petioles. The largest leaf-blades of *P. vitiense* now available are up to 25 by 28 cm. and 13-nerved. The number of staminate spikes in the leaf-axils is somewhat more variable than the 14 described by de Candolle. Our material shows these spikes to be about 10–22 in number, giving the species its most distinctive character. The staminate spikes are up to 6 cm. long and are borne on slender peduncles up to 5 cm. long. The only available pistillate specimen, Gillespie 3360, has broken detached spikes, which offer no unusual character except as to number (which one may anticipate approaches the number of staminate spikes); the stigmas are 3, as usual in this section of the genus.

12. **Piper** (§ *Macropiper*) **Timothianum** A. C. Sm. in Sargentia 1: 10. 1942.

Piper Macgillivrayi var. *fasciculare* Warb. in Bot. Jahrb. 25: 609, as "*fascicularis*." 1898; C. DC. in Denkschr. Akad. Wiss. Wien 85: 264, as "*fascicularis*." 1910, in Ann. Cons. Jard. Bot. Genève 15: 232, as "*fascicularis*." 1912; Turrill in Jour. Linn. Soc. Bot. 43: 35, as "*fascicularis*." 1915; C. DC. in Candollea 1: 172. 1923; Christoph. in Bishop Mus. Bull. 154: 5. 1938.

Piper fascicularis (sic) vel *fasciculatum* Rechinger in Karsten & Schenck, Vegetationsbilder 6: pl. 5. 1908; non *P. fasciculare* Rudge, Pl. Guian. Rar. 1: 9. pl. 4. 1805 (= *Lacistema* sp.); non *P. fasciculatum* Ruiz & Pav. Syst. Veg. 1: 362. 1798.

Piper Macgillivrayi var. *fascicularis* (sic) forma b C. DC. in Jour. Linn. Soc. Bot. 39: 162. 1909.

DISTRIBUTION: Fiji and Samoa. In Fiji the species is common locally in rain-forest and ridge-thickets of Viti Levu at elevations of 550–1200 m.; it is a shrub 2–5 m. high. In Samoa (as *P. Macgillivrayi* var. *fasciculare*) it is said to occur in some abundance on Savaii and Upolu, in essentially similar habitats at elevations up to 1500 m.

FIJI. VITI LEVU: Tholo North: Nandarivatu, Degener & Ordonez 13570 ♀ (A, TYPE, NY, UC, US), Parks 20777 ♂ (Bish), 20786 fr. (Bish), Gillespie 4214 fr. (A, Bish); Nauwanga, Degener 14360 fr. (A, NY, UC, US), 14620 fr. (A, NY); Nandrau, Degener 14891 fr. (A, NY); Namosi: Vicinity of Namosi, Gillespie 2688 ♀ (A, Bish), Parks 20238 fr. (Bish), 20251 fr. (Bish); Korombasambasanga Mt., B. E. Parham 2212 fr. (A). VANUA LEVU: Thakauandrove - Mathuata boundary: Korotini Range, Smith 548 ♀ (Bish, GH, NY, UC, US). WITHOUT DEFINITE LOCALITY: Gillespie 2782 ♀ (Bish), 3124 fr. (Bish).

In proposing this entity as a new species in 1942, I considered its simi-

larity to the Samoan plant which has been passing as *P. Macgillivrayi* var. *fasciculare*, but it seemed to me at that time, as at present, that the plant cannot be placed in "*P. Macgillivrayi*" (i.e. *P. puberulum*, as defined in the present treatment) without undue expansion of that concept. The other varieties of *P. puberulum* have the spikes usually solitary, but sometimes those at the upper nodes are paired. *Piper Timothianum*, on the other hand, has the spikes normally 3-7 per axil, very rarely 2. Several students of the Samoan flora, including Christophersen in 1938, have remarked that the number of spikes may vary from 1 to 4, but I have not observed fewer than 2 (and this very rarely) in the cited Fijian material. Furthermore the spikes (excluding peduncles), both staminate and pistillate, are only 0.8-3.5 cm. long. Christophersen finds that Samoan plants may have the pistillate spikes up to 5 cm. long and the staminate up to 10 cm. *Piper puberulum*, in the sense adopted by me, has the spikes between 4 and 19 cm. long, but the spikes of either sex are rarely less than about 7 cm. long. Although the two species are doubtless closely related and quite possibly interfertile, I fail to see how the present entity can be included in *P. puberulum* without expanding that concept to an unwarranted degree, perhaps even submerging it in *P. latifolium* L. f. Few students of *Piper* will wish to combine species to this extent, in which case the whole Section *Macropiper* would scarcely be divisible into species.

Apparently only Rechinger, in 1908, has thought *P. Macgillivrayi* var. *fasciculare* worthy of specific rank; he used the specific epithets "*fascicularis*" and "*fasciculatum*" indiscriminately, but neither is available for use in *Piper*. The plant was collected at Nandarivatu by both Gibbs and im Thurn, whose specimens were referred to Warburg's variety by de Candolle and Turrill.

13. **Piper** (§ *Macropiper*) **kandavuense** sp. nov.

Frutex 3 m. altus ubique inflorescentia excepta glaber, ramulis teretibus nodis valde incrassatis, internodiis apicem ramulorum versus 2-6 cm. longis; foliis alternatis, petiolis 2-3 cm. longis fere ad apicem conspicue vaginantibus (alis 3-4 mm. latis superne ad petiolum abrupte decurrentibus), laminis chartaceis in sicco olivaceis late ovatis, 10-15 cm. longis, 8-14 cm. latis, basi truncato-subcordatis, apice cuspidato-acuminatis, margine integris, 7 (vel inconspicue 9)-nerviis, nervis e basi divergentibus utrinque conspicue elevatis, rete venularum utrinque haud prominulo; inflorescentiis ♀ solis visis in axillis foliorum apicem ramulorum versus 4 vel 5 aggregatis, pedunculis validis glabris 1-2 cm. longis, spicis paullo post anthesin 2-3 mm. diametro 5-8 cm. longis; rhachi pilis pallidis 0.2-0.4 mm. longis sparse pubescente; bracteis liberis peltatis membranaeis circiter 0.8 mm. diametro breviter stipitatis; ovario globoso-ellipsoideo circiter 1 mm. diametro (immaturo), apice rotundato, stigmatibus 3 patentibus circiter 0.3 mm. longis dense et conspicue brunneo-pilosis et ciliatis coronato.

DISTRIBUTION: Known only from the type collection.

FIJI. KANDAVU: Mt. Mbuke Levu, alt. 200-500 m., *Smith 219* ♀ (Bish, GH, TYPE, NY, UC, US), Oct. 23, 1933 (shrub 3 m. high, in dense forest).

The specimen above described belongs among the allies of *P. latifolium*

L. f., but in several details it differs from my concept of that species. On the whole, it has shorter petioles than *P. latifolium*, at least on leaves of comparable size and maturity, and its petiolar sheaths are slightly broader in proportion and more abrupt distally. In the material of *P. latifolium* which I have seen from the eastern Pacific, the spikes, both staminate and pistillate, are never more than 3, but the original description states that the spikes are 5 or more; whether the original specimen was staminate or pistillate is not stated. Although the stigmas of *P. latifolium* are glandular-puberulent, they are never as conspicuously pilose as those of *Smith 219*.

In view of these differences, and especially the difference pertaining to the stigmatic character, I doubt if *Smith 219* can be referred to *P. latifolium*. No Fijian specimen which has yet come to my attention seems to agree precisely with material of *P. latifolium* from the eastern Pacific, but *Smith 219* seems closest, among Fijian plants, to Linnaeus' species, the limits of which are not yet entirely understood, as stated above.

INSUFFICIENTLY KNOWN ENTITIES FROM FIJI

PIPER (§ *Macropiper*) MACGILLIVRAYI C. DC. var. PARVIFOLIUM C. DC. in DC. Prodr. **16**(1): 335. 1869.

De Candolle's whole treatment of this is as follows: ". . . limbis 0,06 longis, 0,03 latis 5-7-nerviis . . . In ins. Fijee (Barclay ! in h. Kew.)." Leaves with these small dimensions have been observed among the available Fijian collections only on plants referred to *P. melanostachyum* C. DC., in which the leaf-blades are not 7-nerved. It seems probable that *P. Macgillivrayi* var. *parvifolium* is a very depauperate individual of *P. puberulum* var. *glabrum*.

PIPER (§ *Macropiper*) GIBBSIAE C. DC. in Jour. Linn. Soc. Bot. **39**: 163. 1909, in Candollea **1**: 173. 1923.

According to de Candolle, this species is characterized by its small leaf-blades (8×3.5 cm.), which are densely hirtellous beneath and 7-nerved, its hirtellous petioles and peduncles, its short pistillate spikes (3.5 cm. long), and especially its hirsute ovaries. On the basis of the original description this appears to be a distinct species, suggestive of *P. oxycarpum* and possibly *P. puberulum* var. *typicum*. No Fijian material available to me can be referred to *P. Gibbsiae*, which I hesitate to place without seeing the type, *Gibbs 722*, from Nandarivatu, Tholo North, Viti Levu.

PIPER (§ *Macropiper*) ERECTISPICUM C. DC. in Jour. Linn. Soc. Bot. **39**: 163. 1909, in Candollea **1**: 173. 1923.

From the original description and de Candolle's key (5: 173), one may assume that this species is a close relative of *P. Gibbsiae*, differing chiefly in its slightly larger (13×5.8 cm.) and more obviously acuminate leaf-blades, longer pistillate spikes (6 cm. long), and more sparsely pilose ovaries. Without examining the type, it is inadvisable to draw conclusions as to the value of the species, which is based on *Gibbs 599*, from Nandarivatu, Tholo North, Viti Levu.

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NOTES ON THE FLORA OF INDO-CHINA

HUI-LIN LI

THIS paper is based almost entirely on a part of the very excellent and extensive collections of botanical material from the extreme northeastern part of Tonkin, adjacent to the Kwangtung border, assembled by Mr. W. T. Tsang on the second, third, and fourth Lingnan Indo-China Expeditions. These expeditions were sponsored by the Botanical Survey of Lingnan University in co-operation with the Arnold Arboretum and were supported by grants from the latter institution. The second expedition was in the fall of 1936, the third in the spring and early summer of 1939, and the fourth from May to November, 1940. All the material of the first two expeditions, when received from the field, was stored in Canton in order that the necessary herbarium labels could be prepared. The fourth expedition was actually in the field when the Japanese occupied Indo-China, but Mr. Tsang succeeded in returning to Hong Kong with all of his material. Because of the rapidly deteriorating conditions in the Orient, all of the material from the three expeditions was assembled in Hong Kong, and, through the active interest of Prof. F. A. McClure, the Arnold Arboretum share of the collections was shipped to the United States in January 1941. Because of the critical situation in Canton and the increasingly critical one in Hong Kong, time did not permit the actual transcription of the field notes for the numbers involved on the fourth and last expedition; we do, however, have the localities and the inclusive dates of collection for each locality, and we were thus in a position to have the necessary printed herbarium labels prepared.

In the three collections there is a total of about 2000 numbers. Of the second and third expedition collections we normally have four sets of specimens for each number; but the number of duplicates of the fourth collection is very much larger, often running from ten to fifteen specimens for each number.

Mr. Tsang, on all three expeditions, operated in the coastal regions in the vicinity of Ha Coi and the mountainous region inland from Ha Coi and Tien Yen, much of the material being from the mountain ranges immediately south of the juncture of the Kwangsi-Kwangtung-Tonkin boundaries. Naturally, in the collection as a whole, a great many Chinese elements are represented in the form of genera and species originally described from Kwangtung, Kwangsi, and neighboring provinces, as well as the Island of Hainan. When the entire collection is studied, group by group, many additions to the Indo-Chinese flora will result. All specimens cited are deposited in the herbarium of the Arnold Arboretum.

This study was made possible through a grant made from the Milton Fund of Harvard University to Dr. E. D. Merrill, Director of the Arnold

Arboretum, to be utilized in completing the identification work on the recently received botanical collections from various parts of China and neighboring regions.

PROTEACEAE

Helicia Loureiro

Helicia Henryi Diels, Repert. Sp. Nov. **13**: 528. 1915.

Helicia pallidiflora W. W. Smith, Notes Bot. Gard. Edinb. **10**: 179. 1918.

INDO-CHINA: Tonkin, northwest of Mon-cay, Pac-si and vicinity, *W. T. Tsang* 26961, Oct. 1-8, 1936, 7 ft. high, fairly common, growing in thickets, on dry clayey soil, fruits yellow or black; Taai Wong Mo Shan, Chuk-phai, *W. T. Tsang* 27078, Oct. 23-31, 1936, 27252, Nov. 10-17, 1936, 29299, July 1-13, 1939, 7-9 ft. high, fairly common, growing in thickets, on dry clayey or sandy soil, fruits yellow or black. Yunnan, Kwangsi, Hainan. New to Indo-China.

Helicia vestita W. W. Smith, Notes Bot. Gard. Edinb. **10**: 181. 1918.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 30083, May 18 - July 5, 1940. Yunnan. New to Indo-China.

Helicia Tsangii sp. nov.

Arbor parva circiter 3-5 m. alta, ramulis junioribus dense ferrugineo-tomentosis serius glabrescentibus; foliis chartaceis vel subcoriaceis, breviter petiolatis (5-10 mm.), anguste oblongo-ovatis vel oblongo-ob lanceolatis, 17-26 cm. longis, 5.5-9.5 cm. latis, apice plus minusve abrupte acuminatis, basi angustatis, acutis vel cuneatis, margine crasse et remote serratis, supra glabris subnitidis, in sicco olivaceis, subtus glabris costa nervisque leviter subcastaneo-tomentosis exceptis, in sicco brunneis, costa utrinque elevata, nervis lateralibus utrinsecus 12-15, supra distinctis, subtus prominentibus, venis tertiariis utrinque subconspicuis; inflorescentiis axillaribus erectis ad 16 cm. longis, dense subcastaneo-tomentosis, multifloris, bracteis bracteolisque ovato-lanceolatis, ad 2-3 mm. longis, tomentellis, pedicellis 2-4 mm. longis, subcastaneo-tomentosis mox glabrescentibus, solitariis vel binis vel plerumque 2-4-fasciculatis; floribus circiter 15 mm. longis, albis, extus leviter tomentosis; antheris circiter 1.5 mm. longis; ovario circiter 1 mm. longo glabro, stylo gracili glabro; squamis hypogynis oblongo-quadratis, basi leviter cohaerentibus; fructibus valde immaturis subglobosis, circiter 1 cm. diametro, brunneis.

INDO-CHINA: Tonkin, northeast of Mon-cay, Pac-si and vicinity, *W. T. Tsang* 26880, Sept. 27-30, 1936, 10 ft. high, abundant, growing in thickets, fruits brown; Ha-coi, Taai Wong Mo Shan, Chan Uk Village near Chuk-phai, *W. T. Tsang* 28974, May 3-10, 1939, 29174 (TYPE), June 1-9, 1939, 10-15 ft. high, fairly common, growing in thickets, on dry clayey soil, flowers white, fragrant.

A species allied to *Helicia silvicola* W. W. Smith, but distinguished by the much broader, narrowly obovate to oblong-ob lanceolate, coarsely toothed, short-petioled leaves, and by the longer flowers, which are hairy on the outside.

LORANTHACEAE

Elytranthe Blume

Elytranthe cochinchinensis (Lour.) G. Don var. **tonkinensis** (Lecomte) comb. nov.

Elytranthe ampullacea G. Don var. *tonkinensis* Lecomte, Fl. Gén. Indo-Chine **5**: 205. 1915.

INDO-CHINA: Tonkin, Tien-yen, Kau Nga Shan and vicinity, *W. T. Tsang* 27491,

Jan. 1-9, 1937, 2 ft. high, fairly common, on trees in thickets, fruits purplish-red, flowers fragrant.

Three varieties are recognized by Lecomte in Indo-China. The other two are *Elytranthe cochinchinensis* (Lour.) G. Don var. *puberula* (Lecomte) comb. nov. (*E. ampullacea* G. Don var. *puberula* Lecomte, Fl. Gén. Indo-Chine 5: 205. 1915), from Cambodia, and var. *Harmandii* (Lecomte) comb. nov. (*E. ampullacea* G. Don var. *Harmandii* Lecomte, l. c.), from Laos. Danser (Bull. Jard. Bot. Buitenz. III. 16: 5. 1938) refers all three to the type of *Macrosolen cochinchinensis* (Lour.) van Tieghem = *Elytranthe cochinchinensis* (Lour.) G. Don, as representing different forms of a polymorphic species. But the specimens from Indo-China show enough differences to prove that Lecomte is not unjustified in proposing these varieties.

Loranthus Linnaeus

Loranthus cordifolius Wall. in Roxb. Fl. Ind. 2: 222. 1824.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lomg Ngong Village, W. T. Tsang 30430, July 18 - Sept. 9, 1940; Tien-yen, Kau Nga Shan and vicinity, W. T. Tsang 30570, Sept. 23 - Oct. 7, 1940. Eastern India. New to Indo-China.

This belongs in *Scurrula* Linn. in accordance with Danser's scheme of classification.

Loranthus tienyensis sp. nov.

Frutex parasiticus, ramis ramulisque teretibus dense castaneo-tomentosis; foliis firmiter chartaceis, petiolatis, juventute utrinque breviter dense ferrugineo-tomentosis vel subtus secus costam tomentosis, maturitate mox glabris ellipticis, 2.5-4.5 cm. longis, 1.5-2.3 cm. latis, utrinque late rotundatis, in sicco supra olivaceis, subtus paullo pallidioribus, costa supra obscura subtus elevata, nervis lateralibus obsoletis vel subobsoletis; petiolo circiter 7 mm. longo ferrugineo-pubescente; inflorescentiis axillaribus solitariis plerumque bifloris, pedunculis teretibus circiter 5 mm. longis dense breviter subcastaneo-tomentosis; pedicellis teretibus circiter 7 mm. longis; bracteis minutis; calyce subellipsoideo 2-3 mm. longo, margine integro; corolla dense breviter subplumoso-tomentosa, ad 4.5 mm. longa, 3 mm. diametro, apice 4-lobata, lobis obtusis 1 mm. latis; filamentis circiter 1 mm. longis, antheris oblongis 1.5 mm. longis; stylis glabris filiformibus, corollae lobis aequalibus vel paullo longioribus, stigmatibus capitatis.

INDO-CHINA: Tonkin, Tien-yen, Ho Yung Shan and vicinity, W. T. Tsang 30689 (TYPE), Oct. 13 - Nov. 22, 1940.

A very distinct species, characterized by its small elliptic leaves, which are rounded at both ends, without distinct lateral nerves, and with a dense tomentum along the lower portion of the midrib beneath, the mature leaves otherwise being wholly glabrous. It is remotely allied to *Loranthus notothixoides* Hance, differing, among other characters, in the larger leaves and very much longer flowers. In Danser's classification it falls into *Scurrula* Linn.

ANNONACEAE

Goniiothalamus Hooker f. & Thomson

Goniiothalamus chartaceus sp. nov.

Frutex vel arbor parva, ramis ramulisque glabris nigris; foliis sub-

chartaceis glabris breviter petiolatis anguste oblongo-lanceolatis vel lanceolatis, 11–17 cm. longis, 1.7–2.8 cm. latis, breviter obtuse acuminatis, basi acutis, margine leviter revolutis, in sicco olivaceis utrinque concoloribus, minute punctulatis, costa supra leviter impressa subtus distincte elevata, nervis lateralibus utrinsecus 10–12, utrinque subconspicuis, tenuibus, fere ad medium inter costam atque marginem curvato-anastomosantibus, venis tertiariis inconspicuis; petiolo circiter 5 mm. longo; floribus axillaribus solitariis, pedicellis circiter 1.2 mm. longis, glabris, prope basim 3-bracteatis, bracteis 1–1.5 mm. longis acuminatis; sepalis coriaceis oblongo-ovatis, perspicue acuminatis, circiter 9 mm. longis et 4 mm. latis, fere liberis, glabris; petalis exterioribus liberis lanceolatis longe acuminatis, circiter 1.8 cm. longis, petalis interioribus superne coalitis, ovato-triangularibus, breviter acuminatis, circiter 1 cm. longis; staminibus numerosis circiter 1.5 mm. longis; carpellis numerosis minutis brunneo-tomentosis.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lung Wan Village, W. T. Tsang 30097 (TYPE), May 18 – July 5, 1940.

A species characterized by its thin, narrow, punctulate leaves and long and slenderly acuminate outer petals, being quite unlike any previously described species from this region, perhaps most closely allied to *Goniothalamus elegans* Ast.

HAMAMELIDACEAE

Embolanthera Merrill

Embolanthera glabrescens sp. nov.

Frutex vel arbor parva, glabra, ramis brunneo-cinereis teretibus, ramulis gracilibus obscure brunneis; foliis firmiter chartaceis glabris, petiolatis, lanceolatis vel oblongo-lanceolatis, 7–12 cm. longis, 1.5–4 cm. latis, longe acuminatis, basi plerumque perspicue inaequilateralibus, uno latere acutis, altero rotundatis vel late acutis, margine integris subcartilagineis, supra subnitidis, nervis 5–7-jugis arcuatim adscendentibus anastomosantibus, supra paullo elevatis, subtus perspicuis, venulis reticulatis, supra subconspicuis, subtus conspicuis; petiolis canaliculatis, 2–5 mm. longis; inflorescentiis terminalibus solitariis spicatis multifloris, 8–12 cm. longis, glabris, pedunculis 1–1.5 cm. longis; floribus hermaphroditis sessilibus, calyce toto glabro, circa 3.8 mm. longo, infra cum ovario connato, ad basim 2-partito, lobo uno apice breviter fisso, lobis apice ciliatis; petalis perigynis saepissime 5 raro 4–6, in alabastro corrugato-involutis, maturis luteis linearibus, circa 2 cm. longis, 1–1.5 mm. latis, breviter acuminatis, basi utrinque valde auriculatis vel alatis; staminibus 5 raro 4–6 cum petalis alternis eorumque basi leviter connatis, 1.5–2 mm. longis, filamentis 1–1.3 mm. longo, connectivo breviter producto, thecis 2 ovoideis rubro-brunneis basifixis, locellis 4; staminodiis nullis; ovario semi-infero 2-loculari supra pubescente; stylis 2 glabris 6 mm. longis cylindricis acuminatis, ovulo in loculo quove singulo pendulo; fructu capsulari, basi annulato, ovoideo, in valvis 2 dehiscente, 8–10 mm. longo, 1 mm. crasso, epicarpio levi corneo crasso, endocarpio corneo nigricante, calycis limbo circumscisso-deciduo, semine ignoto.

INDO-CHINA: Tonkin, Tien-yen, Ho Yung Shan and vicinity, W. T. Tsang 30709 (TYPE), Oct. 13 – Nov. 22, 1940.

This is an interesting addition to the flora of Indo-China. The genus

Embolanthera was described from a single Philippine collection from Palawan, its type species being *E. spicata* Merr. As a genus, it is strongly characterized by the spicate inflorescences, manifestly auriculate bases of the petals, membranaceous irregularly 2- or 3-lobed calyces, and the absence of staminodes. The present species differs from *E. spicata* Merr. in the narrower, more slenderly acuminate, and generally fewer-nerved leaves, shorter petioles, glabrous spikes which are mostly terminal, and glabrous calyces. The fruits were previously unknown, but unfortunately I am not able to describe the seeds, for in the abundant material now available the seeds are all fallen.

This new species considerably extends the range of the genus. The type was collected at Tien-yen in northeastern Tonkin, near the Kwangtung-Kwangsi border. It is highly probable that the same species, or related ones, may eventually be found also in southern Kwangsi, when the latter area is more extensively explored. The flora of Kwangsi is particularly close to that of Tonkin, as is shown by numerous species in recent collections being present in both areas.

STERCULIACEAE

Reevesia Lindley

Reevesia macrocarpa sp. nov.

Arbor, ramis glabris teretibus, ramulis glabris; foliis firmiter chartaceis, utrinque glabris, pallidis, nitidis, oblongo-ellipticis, 13–18 cm. longis, 4.5–6 cm. latis, acuminatis, basi subrotundatis, leviter trinerviis, costa utrinque elevata, nervis lateralibus utrinsecus 6–8, supra distinctis, subtus perspicuis valde elevatis, prope marginem arcuato-anastomosantibus, venis tertiariis utrinque elevatis; petiolo 2.5–4.5 cm. longo, glabro; floribus ignotis; fructibus longe pedicellatis lignosis obovoideo-oblongis, 5.5–6 cm. longis, 2.5–2.7 cm. latis, 5-lobatis, apice rotundatis, basi acutis, extus griseo-furfuraceis; pedicello circiter 4.5 cm. longo; seminibus (cum alis) circiter 3 cm. longis, alis brunneis circiter 2.2 cm. longis, 0.7 cm. latis, oblongis, apice rotundatis.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lomg Ngong Village, W. T. Tsang 30473 (TYPE), July 18 – Sept. 9, 1940.

A species distinguished in this small genus by its rather large entirely glabrous leaves and the large fruits. It is nearest to *Reevesia longipetiolata* Merr. & Chun of Hainan, but it differs in its vegetative characters as well as in its larger fruits. This is the second actual record of *Reevesia* as occurring in Indo-China. Gagnepain, in Lecomte, Fl. Gén. Indo-Chine 1: 486. 1910, includes the description of *Reevesia thyroidea* Lindl. on the basis of a *Bon* specimen which perhaps came from Tonkin. He states: "L'origine tonkinoise de cette espèce n'est pas certaine, le P. Bon ayant herborisé à Hong-Kong." Merrill, Jour. Arnold Arb. 19: 53. 1938, has credited *Reevesia pubescens* Nast to Tonkin.

DILLENIACEAE

Actinidia Lindley

Actinidia tonkinensis sp. nov.

Frutex scandens, ramis glabris, ramulis junioribus subdecidue breviter

puberulis; foliis chartaceis, longe petiolatis, ovatis vel elliptico-ovatis, 7–12.5 cm. longis, 4.5–6.8 cm. latis, apice acutis vel breviter acuminatis, basi angustatis, margine infra medium integris, sursum distanter serrulatis, in sicco olivaceo-viridibus, utrinque subconcoloribus vel subtus paullo pallidioribus, supra glabris subnitidis, subtus minute consperse stellato-puberulis, nervis lateralibus utrinsecus 6–8 gracilibus utrinque manifestis subtus elevatis, venis tertiariis plus minusve parallelis, supra subconspicuis, subtus distinctis; petiolo 2.2–4.8 cm. longo, primo puberulo demum subglabro; inflorescentiis dense subferrugineo-pubescentibus, cymosis, 4–5 cm. longis, 5–20-floris; pedunculis 2–3 cm. longis; floribus ♂ 5-meris, circiter 1 cm. diametro, pedicellis 0.7–1 cm. longis; sepalis ovatis obtusis extus dense pubescentibus, circiter 4 mm. longis; petalis oblongis glabris, circiter 5 mm. longis et 2 mm. latis, apice rotundatis; staminibus circiter 40, 1-seriatis, filamentis 2–3 mm. longis gracilibus, antheris oblongo-ovatis 1 mm. longis; ovario subgloboso dense pubescente; floribus hermaproditis non visis.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29907 (TYPE), May 18 – July 5, 1940.

A species apparently in the alliance of *A. latifolia* (Champ.) Merr., but distinguished, among other characters, by the leaf base being acute or broadly acute instead of cordate or broadly rounded, the lower surface less pubescent, with scattered stellate hairs, and the more delicate and lax inflorescences with longer and more slender peduncles and pedicels and somewhat smaller flowers.

FLACOURTIACEAE

Bennettiodendron Merrill

Bennettiodendron cordatum Merr. Jour. Arnold Arb. **20**: 352. 1939.

INDO-CHINA: Tonkin, Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27043, Oct. 16–22, 1936, 27122, Oct. 23–31, 1936, 29261, June 23–30, 1939, 5–30 ft. high, fairly common, growing in thickets, in sandy soil; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 30058, May 18 – July 5, 1940.

The type, a flowering specimen, was from Mount Bavi, Tonkin; the above-cited collections are all in fruit. Infructescences narrowly paniculate, 9 to 12 cm. long, sparingly pubescent, ultimately glabrous or nearly so, the longest branches not exceeding 2 cm. in length. Fruits globose, dark brown, glabrous, about 7 mm. in diameter.

THYMELAEACEAE

Wikstroemia Sprengel

Wikstroemia nutans Champ. in Hook. Jour. Bot. Kew Gard. Misc. **5**: 195. 1853.

INDO-CHINA: Tonkin, Tien-yen, Kau Nga Shan, *W. T. Tsang* 27340, Dec. 13–22, 1936, 4 ft. high, fairly common, in thickets, flowers yellow. Kwangsi, Kwangtung, Hainan. New to Indo-China.

ARALIACEAE

Dendropanax Decaisne & Planchon

Dendropanax parviflorus (Champ.) Benth. Fl. Hongk. 137. 1861; Merr. Brittonia **4**: 132. 1941; Li, Sargentia **2**: 45. 1942.

Hedera parviflora Champ. ex Benth. in Hook. Jour. Bot. Kew Gard. Misc. 4: 122. 1852.

Gilibertia parviflora Harms in Engl. & Prantl, Nat. Pflanzenfam. 3(8): 41. 1894.

Textoria parviflora Nakai, Jour. Jap. Bot. 15: 7. 1939.

INDO-CHINA: Tonkin, northwest of Mon-cay, Pac-si and vicinity, *W. T. Tsang* 26981, Oct. 1-8, 1936; Ha-coi, Chuk-phai, Taai Wang Mo Shan, *W. T. Tsang* 27241, Nov. 10-17, 1936. Kwangtung and Kwangsi. New to Indo-China.

CORNACEAE

Cornus Linnaeus

Cornus hongkongensis Hemsl. Jour. Linn. Soc. Bot. 23: 345. 1888.

Benthamia japonica Sieb. & Zucc. var. *sinensis* Benth. in Hook. Jour. Bot. Kew Gard. Misc. 4: 165. 1852.

Dendrobenthamia hongkongensis Hutchinson, Ann. Bot. 6: 93. 1942.

INDO-CHINA: Tonkin, Mount Bavi, *A. Pételot* 2147, June 24, 1939; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29942, May-July, 1940. Southern and eastern China. New to Indo-China.

This species has been much confused with *Cornus capitata* Wall., a species of wide distribution, which also occurs in Tonkin. It differs from Wallich's species chiefly in having a truncate, entire calyx. In addition, it can be distinguished by its leaves being generally broader, more coriaceous, slightly lustrous above and pale green, not grayish nor whitish beneath. In leaf form, size, and length of acumen, the two species are similar.

SAPOTACEAE

Madhuca J. F. Gmelin

Madhuca Tsangii sp. nov.

Arbor ramulis atrobrunneis glabris; foliis ad ramulorum apices subverticillatim dispositis, chartaceis vel subcoriaceis, petiolatis, obovatis, 4.5-6.5 cm. longis, 2.5-3.5 cm. latis, apice obtusis vel late rotundatis, deorsum angustatis, basi cuneatis, utrinque glabris, subtus minutissime punctulatis, costa subtus valde prominente, nervis lateralibus supra inconspicuis, subtus gracilibus, utrinsecus circa 12-15 rectis prope marginem obscurissime arcuatim anastomosantibus; petiolis 1-2 cm. longis; floribus axillaribus 2-7-fasciculatis, pedicellis dense subadpresse pubescentibus, ad 2.5 cm. longis; calyce 6-7 mm. longo extus pubescente, lobis 4 biseriatis ovatis, 5 mm. latis, toto pubescentibus; corollis exsertis, 8 mm. longis, glabris, tubo 2-3 mm. longo, petalis 8 oblongis, 5 mm. longis, 2.5 mm. latis, subrotundatis; staminibus 16 fauce insertis, filamentis 1 mm. longis, antheris 2.5 mm. longis acuminatis; ovario ovoideo pubescente 8-loculari, stylis 1 cm. longis, basi pubescentibus; fructu ignoto.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lomg Ngong Village, *W. T. Tsang* 30271 (TYPE), July 18 - Sept. 9, 1940.

In the pubescent ovary and obovate leaves, this new species resembles *Madhuca Thorelii* (Merr.) H. J. Lam and *Madhuca cambodiana* (H. Lecomte) comb. nov. (*Payena cambodiana* H. Lecomte, Fl. Gén. Indo-Chine 3: 912. 1930). The former is an incompletely known species which, on the basis of the original description, differs from the present species in the smaller leaves, shorter pedicels, and smaller flowers. The latter has larger

leaves with loosely arranged veinlets, as well as shorter pedicels and smaller flowers.

Sideroxylon Linnaeus

Sideroxylon Wightianum Hook. & Arn. var. **tonkinense** var. nov.

A typo speciei differt foliis lanceolatis, ad 13–16 cm. longis, 3–4 cm. latis, longe acuminatis, basi valde attenuatis, petiolis 1.5–2 cm. longis.

INDO-CHINA: Tonkin, Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27044 (TYPE), Oct. 16–22, 1936, 10 ft. high, fairly common, in thickets, on dry sandy soil, flowers pale.

The type of the species was from Kwangtung. This variety differs from the typical form in the much more lanceolate leaves. Lecomte, *Fl. Gén. Indo-Chine* 3: 887. 1930, gives an extensive description of *Sideroxylon Wightianum* Hook. & Arn. var. *Balansae* Lec. but his description applies to a form distinctly different from the one above characterized, its leaves being but 10–12 cm. long, obtusely acuminate, and its petioles being 8–12 mm. in length.

SARCOSPERMATACEAE

Sarcosperma Hooker f.

Sarcosperma laurinum (Benth.) Hook. f. in Benth. & Hook. f. *Gen. Pl.* 2: 655. 1876; Lam & Varos, *Blumea* 3: 195. 1938.

Reptonia laurina Benth. *Fl. Hongk.* 208. 1861.

INDO-CHINA: Tonkin, Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27162, Nov. 1–9, 1936, 20 ft. high, fairly common, in thickets, flowers pale yellow, fragrant; Tien-yen, Kau Nga Shan, *W. T. Tsang* 27415, Dec. 23–29, 1936, 10 ft. high, fairly common, in thickets, flowers light yellow, fragrant; Tien-yen, Ho Yung Shan, *W. T. Tsang* 30726, Oct. 13 – Nov. 22, 1940. Kwangtung, Kwangsi, Hainan, and southern Yunnan. New to Indo-China.

EBENACEAE

Diospyros Linnaeus

Diospyros Morrisiana Hance. *Walp. Ann.* 3: 14. 1852–53, *Jour. Bot.* 18: 299. 1880.

INDO-CHINA: Tonkin, northeast of Mon-cay, Pac-si, *W. T. Tsang* 26973, Oct. 1–8, 1936, 10 ft. high, fairly common, in thickets on dry clayey soil, fruit yellow; Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27313, Nov. 18 – Dec. 2, 1936, 10 ft. high, fairly common, in thickets, fruit yellow; Tien-yen, Kau Nga Shan, *W. T. Tsang* 27385, Dec. 13–22, 1936, 15 ft. high, fairly common, in thickets, on steep slopes, fruits yellow; same locality, *W. T. Tsang* 30484, Sept. 23 – Oct. 7, 1940; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29809, May 18 – July 5, 1940. Kwangtung, Kwangsi, Fukien, Chekiang, Formosa. New to Indo-China.

Diospyros potingensis Merr. & Chun, *Sunyatsenia* 5: 164. 1940.

INDO-CHINA: Tonkin, northeast of Mon-cay, Pac-si, *W. T. Tsang* 26925, Oct. 1–8, 1936, 10 ft. high, fairly common, in thickets, on dry sandy soil, fruits yellow; Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27159, Nov. 1–9, 1936, 28996, May 3–10, 1939, woody, 20 ft. high, fairly common, in thickets, on dry sandy soil, fruits yellow; Dam-ha, Sai Wong Mo Shan, Lomg Ngong Village, *W. T. Tsang* 30191, July 18 – Sept. 9, 1940. Hainan. New to Indo-China.

STYRACACEAE

Rehderodendron Hu

Rehderodendron indochinense sp. nov.

Arbor circiter 13 m. alta, ramulis glabris subcinereis; foliis chartaceis glabris utrinque concoloribus elliptico-oblongis, 7–10 cm. longis, 3–3.5 cm.

latis, falcato-acuminatis, basi anguste acutis, margine minute distanter glanduloso-denticulatis, nervis lateralibus utrinsecus 6–8 curvatis circiter ad marginem arcuato-anastomosantibus, cum venulis reticulatis utrinque perspicuis; petiolis 5–7 mm. longis glabris; paniculis axillaribus ad 5 cm. longis, dense substellatim cinereo-tomentosis, pedicellis 6–10 mm. longis, bracteolis ad basim pedicelli lanceolatis, cinereo-tomentulosi, 4 mm. longis, deciduis; calyce campanulato 4 mm. alto, 5-dentato, dentibus triangularibus acuminatis; corolla 5-partita, lobis elliptico-oblongis obtusis, 1.4 cm. longis, 5 mm. latis, utrinque substellatim cinereo-tomentulosi; staminibus 10, corollae tubo adnatis, exsertis, alternis longioribus, stylis cinereo-tomentulosi, 1.5 mm. longis, stigmatibus capitatis; ovario 5-loculari; fructibus glabris magnis cylindrico-oblongis, 7.5 cm. longis, 2.8 cm. crassis, apice planis vel leviter depressis, in sicco rubro-brunnescentibus, 10-costatis, exocarpio duro 1 mm. crasso, mesocarpio 8–10 mm. crasso inter processos endocarpium fibroso-spongioso, endocarpio lignoso 8–10 mm. crasso, processis circiter 10 longitudinalibus 8–10 mm. latis et 1 mm. crassis ornato; seminibus oblongo-linearibus, 5 cm. longis.

INDO-CHINA: Tonkin, Chapa, *A. Pételot* 6258 (TYPE, flowering specimen), in forests, alt. about 1500 m., February 1931; Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27094, Oct. 23–31, 1936 (fruiting specimen), a tree 40 ft. high, fairly common, growing in thickets, on dry loamy soil, fruit brownish yellow.

This species is allied to *Rehderodendron kwangtungense* Chun, *R. Hui* Chun, and *R. praeteritum* Sleumer, all from Kwangtung, but it may be distinguished by its entirely glabrous, much smaller leaves and the larger, longer, and relatively narrower fruits. This is the second species of the genus known from Indo-China. The other one is *R. macrocarpum* Hu, a species extending from Szechuan through Kweichow to Kwangsi, which is represented by *A. Pételot* 4767 from Tonkin.

Huodendron Rehder

***Huodendron parvifolium* sp. nov.**

Arbor parva circiter 7 m. alta inflorescentiis exceptis glabra, ramulis gracilibus teretibus; foliis chartaceis oblongo-ellipticis, 5.5–7.5 cm. longis, 2–2.5 cm. latis, utrinque subopacis subconcoloribusque, distincte acuminatis, basi acutis, margine leviter revolutis, nervis lateralibus utrinsecus 5–7 arcuatis ad marginem curvato-anastomosantibus, utrinque elevatis distinctis, venis tertiariis transversis, utrinque subconspicuis; petiolis 1–1.3 cm. longis glabris in sicco nigris; floribus ignotis; infructescentiis axillaribus puberulis, racemosis, ad 3 cm. longis; fructibus ovoideis cinereo-puberulis, 7.5 mm. longis, 5 mm. latis, loculicide dehiscentibus, pedicellis 0.7–1 cm. longis, manifeste recurvis; calycibus persistentibus puberulis, cupuliformibus, 4 mm. longis, minute 5-dentatis; seminibus brunneis, 2–3 mm. longis.

INDO-CHINA: Tonkin, northeast of Mon-cay, Pac-si and vicinity, *W. T. Tsang* 26886 (TYPE), Sept. 27–30, 1936, a small tree, 20 ft. high, fairly common, in thickets, on dry clayey soil, fruit light gray.

This is the second species of this characteristic Chinese genus to be known from Indo-China. It differs from the other Indo-Chinese species of the genus in its smaller leaves, which are dull on both sides, in the relatively larger fruits, which are racemously arranged in short, simple infructescences, and in the very small calyx teeth.

Styrax Linnaeus*Styrax argentifolius* sp. nov.

Frutex circiter 3–5 m. altus, ramulis novellis dense adpresse furfuraceo-lepidotis, indumento cinereo-brunneis; ramis gracilibus glabris; foliis firmiter chartaceis, supra glabris viridibus opacis, subtus dense minute adpresse lepidulotis et indumento cinereo-albido nitidis, oblongis, 7–17 cm. longis, 2–5 cm. latis, longe acuminatis, basi acutis, margine integris, nervis lateralibus utrinsecus 6–8, supra subconspicuis, subtus elevatis prominentibus, curvatis, arcuato-anastomosantibus, venis tertiariis dense reticulatis, utrinque subconspicuis; petiolis 0.7–1 cm. longis, adpresse furfuraceo-lepidotis; inflorescentiis ignotis; infructescentiis axillaribus vel terminalibus, ad 6 cm. longis, dense adpresse furfuraceo-lepidotis; fructibus subovoideis distincte rostratis, ad 2.5 cm. longis et 1.8 cm. crassis, dense adpresse lepidulotis, calyce deciduo minuto, 4 mm. longo, irregulariter cupuliformi, extus dense lepidoto.

INDO-CHINA: Tonkin, Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27127, Oct. 23–31, 1936, 29335, July 1–13, 1939, 10–16 ft. high, fairly common, in thickets, on moist sandy soil, fruits dirty white to gray; Dam-ha, Sai Wong Mo Shan, Long Ngong Village, *W. T. Tsang* 30238 (TYPE), July 18 – Sept. 9, 1940.

This species simulates *Styrax suberifolius* Hook. & Arn. of southern China, but may be readily distinguished by its appressed furfuraceous-lepidote indumentum never being stellate, and by its larger, distinctly rostrate fruits.

SYMPLOCACEAE

Symplocos Jacquin*Symplocos Delavayi* Brand, Repert. Nov. Sp. 3: 218. 1906.

INDO-CHINA: Tonkin, Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27206, Nov. 10–17, 1936, a small tree, 20 ft. high, fairly common, growing in thickets, fruits black. Yunnan, southeastern Tibet, and northern Burma. New to Indo-China.

Symplocos indochinensis sp. nov. Subgen. *Hopea*, § *Bobua*, *Lodhra*.

Arbor 5–7 m. alta, ramis cinereo-brunneis, ramulis novellis ferrugineis, longe patule villosis, ramis vetustioribus glabris; foliis chartaceis breviter petiolatis oblongo-ellipticis, 7–12 cm. longis, 2–4 cm. latis, acuminatis, basi late acutis, margine minute distanter denticulatis vel integris, utrinque subconcoloribus, supra parce pilosis vel glabrescentibus haud nitidis, subtus consperse villosis, costa supra impressa, nervis lateralibus utrinsecus circa 4 vel 5 arcuato-anastomosantibus, supra impressis, subtus elevatis prominentibus, venis tertiariis reticulatis, supra subelevatis subconspicuis, subtus elevatis; petiolis brevibus ad 5 mm. longis, dense patule ferrugineo-villosis; inflorescentiis axillaribus glomeratis paucifloris sessilibus, axillaribus et in axillis defoliatis in ramulis annotinis; floribus sessilibus, bracteis late ovatis dense pubescentibus, 1 mm. longis; calycis tubo crasso circa 1 mm. longo, lobis late ovatis pubescentibus, 1 mm. longis; petalis 5 oblongis, 3 mm. longis, utrinque glabris; staminibus circa 25, filamentis gracilibus liberis glabris, circa 4 mm. longis; disco annulari cinereo-pubescente, ovario 3-loculari, stylo 4 mm. longo; fructibus globosis levibus glabris, 6 mm. diametro, calyce persistente.

INDO-CHINA: Tonkin, northeast of Mon-cay, Pac-si, *W. T. Tsang* 26902 (TYPE), Sept. 27–30, 1936, a small tree, 17 ft. high, fairly common, in thickets on dry clayey soil, flowers white, fragrant; Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang*

27027, Nov. 10–17, 1936, a tree 20 ft. high, fairly common, in thickets, fruits blackish-blue; Chan Uk Village near Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 29130, May 21–31, 1939, a tree 15 ft. high, fairly common, in thickets, on dry clayey soil, fruits black; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 30047, May 18 – July 5, 1940.

In the pubescence of the branches and leaves, and in the sessile glomerulate inflorescences, this species is apparently close to *S. yunnanensis* Brand. It differs from the latter by its thinner, much shorter, and relatively broader leaves. Most of the inflorescences are in the axils of fallen leaves, and the smooth, globose sessile fruits are all borne on the older leafless branches.

OLEACEAE

Linociera Swartz

Linociera verticillata Gagnep. Bull. Soc. Bot. France **79**: 788. 1932 [1933], et in Lecomte, Fl. Gén. Indo-Chine **3**: 1072. f. 122, 1. 1933.

INDO-CHINA: Tonkin, Tien-yen, Ho Yung Shan and vicinity, *W. T. Tsang* 30697, Oct. 13–22, 1940. Annam. New to Tonkin.

Olea Linnaeus

Olea cordatula sp. nov.

Arbor parva circiter 10 m. alta, ramis ramulisque dense breviter pubescentibus, conserpe lenticellatis; foliis amplis rigidis coriaceis subsessilibus vel brevissime petiolatis late oblongo-oblancoelatis, 14–29 cm. longis, 4.5–9.5 cm. latis, acuminatis, basi anguste cordatis, margine remote dentato-serratis, supra costa nervisque valde impressis exceptis glabris, in sicco olivaceo-brunneis, subtus paullo pallidioribus perspicue breviter molliter pubescentibus, costa supra impressa subtus distincte elevata, nervis lateralibus 18–22 adscendentibus prope marginem arcuato-anastomosantibus, supra impressis, subtus valde elevatis, rete venularum supra leviter impresso subtus obscuro; petiolo subnullo vel ad 4 mm. longo, dense pubescente, supra canaliculato; inflorescentiis paniculatis axillariibus, ad 6 cm. longis et 2.5 cm. latis, molliter pubescentibus, floribus (im-maturis) minutis, pedicellis 1 mm. longis; calycibus 0.5 mm. altis ad medium 4-lobatis, lobis ovatis acutis extus pubescentibus; corolla pallide lutea, 1 mm. longa, 1.5 mm. diametro, ad medium lobata, lobis acutis valvatis margine revolutis; antheris subsessilibus ad 0.5 mm. longis; ovario ovoideo, stylo brevi, stigmate inconspicuo; fructibus ovoideis nigris glabris, 1–1.2 cm. longis, 5–6 cm. crassis.

INDO-CHINA: Tonkin, Ha-coi, Chuk-Phai, Taai Wong Mo Shan, Chan Uk Village, *W. T. Tsang* 29241 (TYPE), June 10–22, 1939, a tree 30 ft. high, fairly common, in thickets, on dry clayey soil, flowers pale yellow; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 30081, May 18 – July 5, 1940, with young fruits; Dam-ha, Sai Wong Mo Shan, Lomg Ngong Village, *W. T. Tsang* 30170, July 18 – Sept. 9, 1940, with mature fruits.

This species is characterized by its large broadly oblong-oblancoelate rigid coriaceous distinctly toothed leaves, which are narrowly cordate at the base, nearly sessile, and softly pubescent beneath. The flowers, probably not fully developed, show the corolla divided to about the middle. It seems to be more appropriate to refer this species to *Olea* rather than to *Linociera*, although it suggests no close relationships to any of the described species of either genus.

Ligustrum Linnaeus

Ligustrum retusum Merr. Lingnan Sci. Jour. **14**: 49. 1935.

INDO-CHINA: Tonkin, Tien-yen, Ho Yung Shan and vicinity, *W. T. Tsang* 30644, Oct. 13 – Nov. 22, 1940. Hainan. New to Indo-China.

RUBIACEAE

Xanthophytopsis Pitard

Xanthophytopsis Balansae Pitard in Lecomte, Fl. Gén. Indo-Chine **3**: 90. fig. 10, 7, 8. 1922; Chun & How, Sunyatsenia **4**: 13. pl. 4. 1939.

INDO-CHINA: Tonkin, Tien-yen, Kau Nga Shan and vicinity, *W. T. Tsang* 30583, Sept. 23 – Oct. 7, 1940; Tien-yen, Ho Yung Shan and vicinity, *W. T. Tsang* 30704, Oct. 13 – Nov. 22, 1940.

The second collection of this new genus from Tonkin. This species has also been recorded from Kwangtung, near the Indo-Chinese border.

Xanthophytopsis kwangtungensis Chun & How, Sunyatsenia **4**: 14. pl. 5. 1939.

INDO-CHINA: Tonkin, northeast of Mon-cay, Pac-si and vicinity, *W. T. Tsang* 26293, Oct. 1–8, 1936, a shrub 2 ft. high, abundant, growing in thickets on dry clayey soil, flowers white, odorless; Ha-coi, Chuk-phai, Taai Wong Mo Shan and vicinity, *W. T. Tsang* 27037, Oct. 16–22, 1936, 29015, May 3–10, 1939, 29433, Aug. 1–31, 1939, a shrub 2 ft. high, fairly common, growing in thickets, on dry clayey soil, flowers white, fruits brown; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29880, May 18 – July 5, 1940.

This species, the second one of the genus, was originally described from western Kwangtung, near the Tonkin border. New for Indo-China.

Randia Linnaeus

Randia leucocarpa Champ. ex Benth. in Hook. Jour. Bot. Kew Gard. Misc. **4**: 194. 1852.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Long Ngong Village, *W. T. Tsang* 20420, July 18 – Sept. 9, 1940. This is a fruiting specimen; its leaves are larger than are those of the Chinese form. Kwangtung. New to Indo-China.

Randia acuminatissima Merr. Philip. Jour. Sci. **15**: 259. 1919.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29904, May 18 – June 5, 1940. China: Kwangtung, Hainan. New to Indo-China.

Mussaenda Linnaeus

Mussaenda erosa Champ. in Hook. Jour. Bot. Kew Gard. Misc. **4**: 193. 1852.

INDO-CHINA: Tonkin, Tien-yen, Kau Nga Shan, *W. T. Tsang* 27461, Jan. 1–9, 1937, climber, 7 ft. high, fairly common, growing among scattered shrubs, fruits black; same locality, *W. T. Tsang* 30540, Sept. 23 – Oct. 7, 1940; Ha-coi, Taai Wong Mo Shan, *W. T. Tsang* 29071, May 11–20, 1939, 29550, Sept. 11–23, 1939, climber, 7–10 ft. high, fairly common, growing in thickets, fruits yellow; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29990, May 18 – July 5, 1940. Southern China. New to Indo-China.

Mussaenda longipetala sp. nov.

Frutex scandens, ramulis teretibus perspicue subpatule ciliato-villosis; foliis membranaceis vel submembranaceis, in paribus aequalibus, oblongo-ovatis vel elliptico-ovatis, 8–12 cm. longis, 3.5–6 cm. latis, longe acuminatis, basi late acutis vel subrotundatis, utrinque perspicue molliter villosis, nervis lateralibus utrinsecus 6–8, curvato-adscendentibus, utrinque conspicuis, venis tertiariis subconspicuis vel inconspicuis; petiolis 0.5–1 cm.

longis dense villosis; stipulis linearibus 6–8 mm. longis caducis; inflorescentiis terminalibus cymosis compactis circiter 5 cm. longis, breviter ramosis, perspicue patule albido-villosis vel ciliatis, bracteis bracteolisque linearibus 5 mm. longis, floribus sat numerosis subsessilibus confertis; calycis tubo crasso, 2 mm. longo, dense ciliato, lobis normalibus 4 vel 5 linearibus, 6–8 mm. longis, 1–2 mm. latis, dense villosis, longe acuminatis, uno interdum petaloideo ovato, 4.5–5.5 cm. longo, acuminato, utrinque longe consperse villosa, stipitato; stipite perspicue ciliato ad 2 cm. longo, nervis 5–7; corollae tubo circiter 3 cm. longo et 2 mm. lato, sursum leviter ampliato, extus perspicue villosa, intus superne leviter pubescente, lobis 5 lanceolatis, 1.2 cm. longis, 1.5 mm. latis, longe acuminatis, extus villosis; staminibus medio tubi affixis, antheris 4 mm. longis, basi bifidis; stylo tubi longitudinem aequante, glabro, apice vix lobato.

INDO-CHINA: Tonkin, Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 29811 (TYPE), May 18 – July 5, 1940.

This species is near *Mussaenda subsessilis* Pierre, differing in the leaves being mostly rounded at the base, the much smaller petaloid sepals, the much narrower and longer corolla-lobes, and the stamens inserted near the middle of the corolla-tube, which is slender throughout and only slightly enlarged from the insertion of the anthers upward.

Urophyllum Wallich

Urophyllum chinense Merr. & Chun, *Sunyatsenia* 2: 19. pl. 10. 1934.

INDO-CHINA: Tonkin, Ha-Coi, Taai Wong Mo Shan and vicinity, *W. T. Tsang* 27220, Nov. 10–17, 1936, 29219, June 10–22, 1939, 29516, Sept. 1–10, 1939, a shrub 5–7 ft. high, fairly common, in thickets, flowers white, fragrant, fruits yellow or black; Tien-yen, Kau Nga Shan, *W. T. Tsang* 27434, Dec. 23–29, 1936, a shrub 5 ft. high, abundant, in thickets, fruits yellow; Dam-ha, Sai Wong Mo Shan, Lung Wan Village, *W. T. Tsang* 30094, May 18 – June 5, 1940; Tien-yen, Ho Yung Shan, *W. T. Tsang* 30673, Oct. 13 – Nov. 22, 1940. Also represented by the following collections from Kwangsi Province: *W. T. Tsang* 23879, 24055, 24690. It was originally described from Kwangtung specimens. New to Indo-China.

Gardenia Ellis

Gardenia stenophylla Merr. Philip. Jour. Sci. 19: 678. 1922.

INDO-CHINA: Tonkin, Ha-coi, Chuk-phai, Taai Wong Mo Shan, *W. T. Tsang* 27063, Oct. 23–31, 1936, 28955, May 3–10, 1939, 29019, May 11–20, 1939, 29598, Sept. 11–23, 1939, a shrub 1.2–2 ft. high, fairly common, growing in thickets, in sandy soil, flowers white, fragrant, fruits yellow; Dam-ha, Sai Wong Mo Shan, *W. T. Tsang* 29820, May 18 – July 5, 1940, 30402, July 18 – Sept. 9, 1940. Hainan. New to Indo-China.

Psychotria Linnaeus

Psychotria rubra (Lour.) Poir. var. *lanceolata* var. nov.

A typo speciei differt foliis oblongo-lanceolatis, 12–16 cm. longis, 2–3 cm. latis, apice longe acuminatis, basi longe attenuatis.

INDO-CHINA: Tonkin, Ha-coi, Taai Wong Mo Shan, Chan Uk Village near Chuk-phai, *W. T. Tsang* 28959 (TYPE), May 3–10, 1939, a shrub 4 ft. high, abundant, growing in thickets on sandy soil, flowers pale yellow, fragrant.